USAID | PREDICT

FROM THE AMERICAN PEOPLE

SEMI-ANNUAL REPORT

2019

REDUCING PANDEMIC RISK, PROMOTING GLOBAL HEALTH

ACKNOWLEDGMENTS

This publication was prepared by the PREDICT Consortium headquartered at the One Health Institute (OHI), School of Veterinary Medicine, University of California, Davis.

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ON THE COVER

Photo: Ebola Host Project's Mohamed Turay untangles a bat from a mist net in Sierra Leone. PREDICT's Ebola Host Project, a regional effort across West Africa, is working to identify the animal host species of ebolaviruses. Credit: Simon Townsley

Photo: (L-R) Jonna Mazet with PREDICT/Mongolia Country Coordinator Enkee Shiilegdamba

DIRECTOR'S LETTER

Introduction

The PREDICT Project, led by its in-country teams, has contributed to amazing advancements in local and global health security over the life of the project. Because of the dedication and smart surveillance work of the diligent participants, countries and communities are more aware than ever of zoonotic disease threats and what can be done to reduce risks. Despite these efforts and the giant steps forward, spillovers of viral pathogens do happen, and we must be vigilant in order to recognize them and respond rapidly for the best control outcomes possible. It has been eight months since the Democratic Republic of Congo declared a new outbreak of Ebola virus disease in North Kivu Province. In that time, over 1,200 individuals have been infected, and the disease has claimed over 800 lives. Response teams continue to battle the outbreak in a complex social and political environment, and while the number of cases continues to rise, there have been promising developments in our ability to prevent and contain the spread of this disease. Preliminary assessments in the efficacy of the candidate vaccine and ring vaccination strategy provide needed hope, though other assessments of the social challenges reaching affected communities for response and prevention efforts, including vaccine delivery, are a sober reminder that science and evidence-based interventions can fall short without investments in understanding the human social and behavioral elements critical for their success.

Over the past six months, the PREDICT Ebola Host Project teams in West Africa continued to build an evidence base supporting Ebola and other filovirus prevention efforts by investigating the underlying drivers of viral spillover and spread and the wildlife host species that may pose greatest risk. Building on our earlier discovery of a new ebolavirus in Sierra Leone (*Bombali ebolavirus* in bats), our team, together with the US Centers of Disease Control and Prevention, detected Marburg virus in Egyptian rousette

bats in that country, the first time the virus has been detected west of Gabon. Meanwhile in Liberia, our PREDICT team detected *Zaire ebolavirus* in a greater long-fingered bat, with further genetic investigations showing it was either the same or a close relative of the virus that caused the West Africa outbreak. Recently, in early April, a team of European researchers and partners in Kenya (not affiliated with PREDICT) detected *Bombali ebolavirus*, also in *Mops condylurus* bats, in the Taita Hills near the border with Tanzania, validating our assumptions that this new ebolavirus is geographically widespread and may pose a risk for spillover across the continent, as these bats favor roosting sites near villages and dwellings.

PREDICT has been designed using the One Health approach, recognizing that to prevent spillover of these viruses from wildlife, you must invest in understanding social and behavioral factors that put people and their domestic animals at risk. Since 2014, our teams in over 28 countries have been working with communities using the social science toolkit to build relationships and trust; raise awareness of zoonoses and risks of transmission and spread; and understand the cultural systems, behaviors, and practices that could facilitate viral spillover and spread. In addition, our teams have been working to strengthen the workforce and systems for improved disease surveillance, detection, and health security. In DR Congo, PREDICT led a workshop on Ebola preparedness in Goma, highlighting risks to human communities and the critically endangered mountain gorilla population, which is also susceptible to the disease. In Kenya, PREDICT teams brought the Smithsonian National Museum of Natural History "Outbreak" exhibit to communities in Lakipia, using an innovative educational approach featuring the immersive experience in outbreak and zoonotic disease education combined with a workshop on biosecurity and prevention. In Tanzania, we launched a monthlong One Health workshop for professionals in the Lake Zone, which borders DR Congo, along with Burundi, Rwanda, and Uganda, and is the designated hot zone for implementation of Tanzania's Ebola Contingency Plan.

We are proud to highlight these successes in our 2019 Semi-annual Report, another round of amazing contributions to global health and security. Our project, which is building to a crescendo at the end of a second 5-year investment phase from USAID, is shifting focus now towards data analysis and characterization of zoonotic disease risk, an exciting phase that promises to yield even more evidence and insights to improve our understanding of pandemic threats, their origins, and, we hope, their eventual demise.

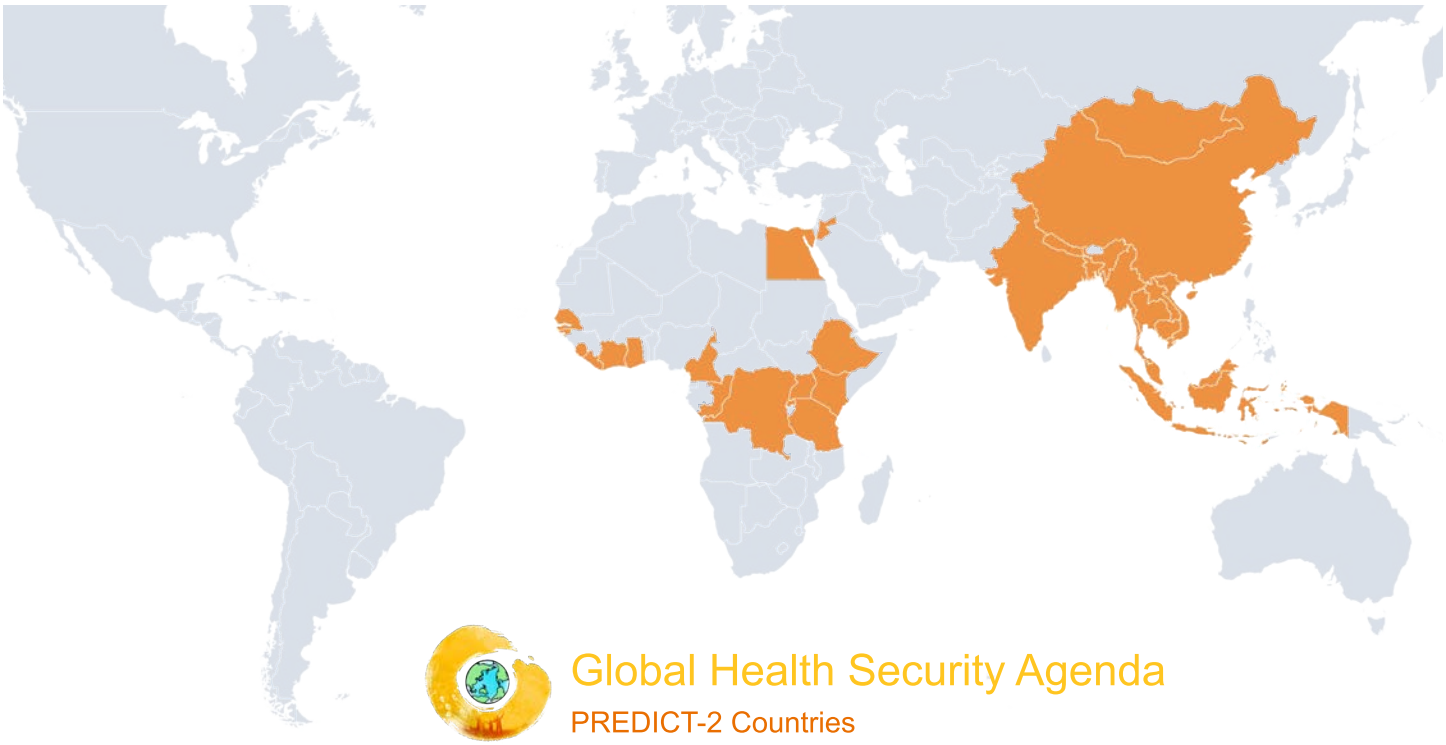
Best regards,

Jonna AK Mazet, DVM, MPVM, PhD
Professor and Global Director
One Health Institute & USAID PREDICT Project
University of California, Davis

Photo: PREDICT/Myanmar team sampling a bat

PREFACE

The PREDICT Consortium: putting One Health in practice



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FROM THE AMERICAN PEOPLE

PREDICT, a project of USAID's Emerging Pandemic Threats (EPT) program, was initiated in 2009 to strengthen global capacity for detection and discovery of viruses with pandemic potential that can move between animals and people. Those include filoviruses, such as the ebolavirus and Marburg virus; influenza viruses; coronaviruses, the family to which SARS and MERS belong; and paramyxoviruses, like Nipah virus. PREDICT has made significant contributions to strengthening global health security by improving surveillance and laboratory diagnostic capabilities for new and known viruses.

Now working with partners in 30 countries, PREDICT is continuing to build platforms for priority viral surveillance and for identifying and monitoring zoonotic pathogens or those that can be shared between animals and people. Using the One Health approach, the project is investigating the behaviors, practices, and ecological and biological factors driving disease emergence, transmission, and spread. Through these efforts, PREDICT is improving global disease recognition and beginning to develop strategies and policy recommendations to minimize pandemic risk.

PREDICT is working to strengthen global capacity for detection and discovery of zoonotic viruses with epidemic and pandemic potential, including the Ebola, influenza, and Zika viruses that have been recent causes of devastating disease and necessary impetuses of dramatic and resource-intensive responses. The project is actively and diligently implementing GHSA activities in target countries aimed at developing and operationalizing strategies to improve disease management efficiencies in the short term, and reduce zoonotic pathogen spillover, amplification, and spread in the long term, through improved public health policies and risk-reducing mitigation efforts. In every country of engagement, we work hand-in-hand with governmental and non-governmental stakeholders to develop and implement activities that are tailored to country and regional priorities, and specifically designed to strengthen capabilities and ensure lasting positive effects from our engagements.

PREDICT Consortium & Management

The USAID/PREDICT Consortium is a functionally collaborative working team that implements the project through in-country partners and benefits from the experience of world leaders in zoonotic disease detection and surveillance, epidemiology, disease ecology, and risk characterization. PREDICT's consortium includes partnerships with ministries of health, agriculture, and environment, and implementing university and NGO partners in 30 countries.

PERSONNEL

PREDICT's international consortium of partners consists of

232 in-country staff

99% of whom are citizens of the host countries where they serve

PARTNERSHIPS

PREDICT has executed 22 subaward agreements since the start of the project, of which 90% are with foreign government entities and laboratories in Asia and Africa. These partnerships enable PREDICT to further advance capabilities for zoonotic disease surveillance, detection, and response.

COMMUNICATIONS

Follow PREDICT teams around the world on Twitter

@PREDICTproject

Join ResearchGate to connect with PREDICT Consortium scientists and to access publications and presentations.

Committed to open data, our host country government-approved findings are available online through the PREDICT BioProject on GenBank and through the HealthMap-hosted data portal at **www.data.predict.global**.

USAID/PREDICT global-level consortium institutions

- **UC Davis' One Health Institute**, based in the highest rated veterinary school in the world, is active all over the globe, working at the interface of animals, people, and the environment to solve complex problems that impact health and conservation.
- **EcoHealth Alliance** is the first group to identify bats as the reservoir of SARS-like coronaviruses, to define hotspots of emerging diseases, and identify drivers of disease emergence.
- **Metabiota, Inc.** has made seminal discoveries regarding the role of hunting of nonhuman primates and food handling in moving animal pathogens to humans.
- **Smithsonian Institution and the National Zoo** are among the founders of the field of conservation biology.
- **Wildlife Conservation Society** is the first conservation organization with a dedicated team of wildlife veterinarians deployed around the world, with programs focused on environmental stewardship and health problem-solving.
- Other global partners include **Columbia University**;, **Epidemico (HealthMap)**, and the **International Society for Infectious Disease**.

Photo: PREDICT/Bangladesh team sampling crows

SUCCESS STORIES

Highlights from our teams around the world

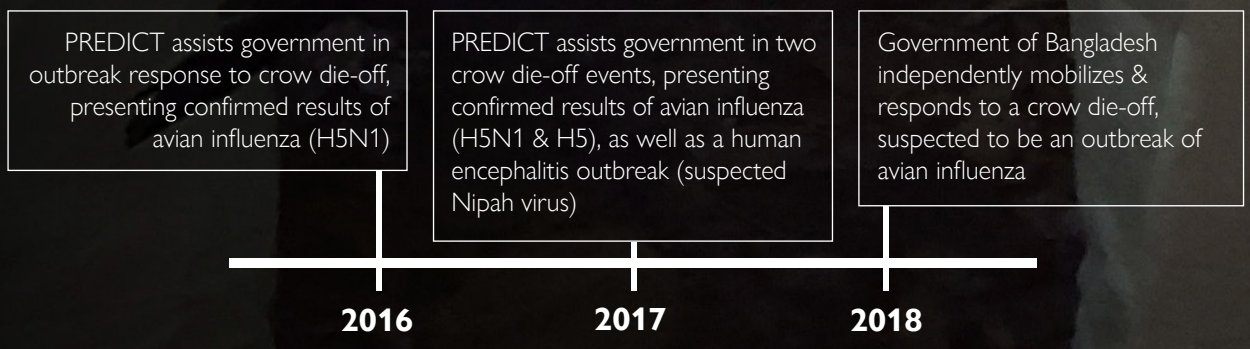
SUCCESS STORY

Strengthening National Capacity for Outbreak Response in Bangladesh

Live bird markets are very common in many parts of Southeast Asia, including Bangladesh, where they serve as the economic networks for selling and trading poultry. Beyond buyers and sellers, these markets draw the attention of wild birds like crows, foraging for food. This interface of wild birds, humans, and domestic avian species presents a possible avian influenza biosecurity hazard. PREDICT/Bangladesh has been working with government partners to strengthen outbreak response capabilities since 2016, when the team played a lead role in crow mortality outbreak response, collecting samples from dead and live birds at the live bird markets and testing them at partner laboratories for zoonotic diseases.

More recently, on December 21, 2018, dead crows in Jessore were reported to the Institute of Epidemiology, Disease Control and Research (IEDCR). IEDCR contacted the PREDICT/Bangladesh team, and its members attended meetings in Dhaka to support the Government of Bangladesh's leadership and to help develop a plan for outbreak response. As part of the plan, PREDICT provided training to a multidisciplinary government team that included officials from both IEDCR and the Department of Livestock Services (DLS). PREDICT also provided hands-on training in avian sampling methods, proper personal protective equipment (PPE) and biosafety, and proper disposal of biohazardous waste/carcasses to the DLS team and members of the Field Epidemiology Training Program—Bangladesh (FETPB) Veterinary Fellowship.

The Government of Bangladesh outbreak team led the response and collected samples from crows that were sent to the Bangladesh Livestock Research Institute (BLRI) laboratory for testing. During the outbreak, the rapid mobilization and response demonstrates that the Government has improved national health security capacity for outbreak response, especially for diseases emerging in wildlife—often a gap in national surveillance and detection systems. Over time, PREDICT support helped advance this capability, and Bangladesh is now increasingly self-reliant in zoonotic disease prevention and control.



Recent PREDICT discoveries have identified bats as the host species for multiple zoonotic viruses. But identification does not equal a call for eradication. In fact, PREDICT strives to underscore the ecological importance of bats and the need to conserve their populations and the habitats on which they depend. Community engagement and feedback is essential to PREDICT's strategy for zoonotic disease risk reduction, which includes raising awareness of ecosystem health and conservation in conjunction with public health.

KENYA: Outbreak exhibit, "bat book" leads to action, interventions

In Kenya, PREDICT held several events with communities in Laikipia County (Leikiji, Mpala, Ol Jogi, and Ilmotiok). The team brought a mobile "Outbreak" exhibit (developed in collaboration with the Smithsonian National Museum of Natural History) to catalyze dialogue on the disease risks posed by exposure to wildlife, and help illustrate best practices for disease prevention and control.

Some community leaders expressed concern about the role of bats in disease transmission, as bats are common around their homes and public buildings. In response, *Living Safely with Bats*—a behavior change and risk communication book created by PREDICT—was distributed to community leaders, teachers, and health liaisons as a resource. The book helps identify practical ways to reduce the risk of disease, such as basic home improvement options that prevent bats from roosting in homes and community spaces.

During visits, our team observed that community members in Ol Jogi were putting these best practices into action through the renovation of a community center. The center's roof had multiple holes, allowing bats to freely enter and roost inside, close to people. Following PREDICT/Kenya's engagement, Ol Jogi residents reinforced the center's roof to fill the holes and gaps, making the building unusable as a roosting site. This basic intervention is now being considered for implementation in homes and other public structures in Ol Jogi.

GUINEA: Bat book & podcast reach at-risk groups at heart of West Africa Ebola outbreak

Over 3,000 miles away in Guinea, PREDICT has been working to reduce the risk of disease transmission in the Forest Region, which has an estimated population of 1,335,274 and is considered to be the origin for the West Africa Ebola outbreak. Over the past six months (October 2018–March 2019) our team used the *Living Safely with Bats* book to target at-risk groups such as hunters and farmers, engaging over 4,000 individuals.

SUCCESS STORY

From East to West Africa: Reducing Risks of Zoonotic Disease Transmission

L-R: Presenting the mobile "Outbreak" exhibit (credit: PREDICT/Kenya), radio interview on "Health for All" (credit: PREDICT/Guinea)

PREDICT also worked with a local radio station to record an interactive episode of the Guinea podcast series "Health for All." Broadcast throughout the Forest Region in French and four other national dialects (Kissi, Toma, Guerze, and Malinke), the episode focused specifically on the *Living Safely with Bats* book. As evidence of the podcast's impact, the Government of Guinea specifically requested that PREDICT intensify risk communication activities upon notice of a confirmed death from Lassa Fever. The Health for All podcast was broadcast daily in the affected region for one month.

Empowering Youth to be One Health Leaders

In Kenya, our team has found that primary school students are highly attuned to the risks of living in close proximity with bats. They were the most receptive group to messaging regarding biosafety measures.

PREDICT visited primary schools in three communities in Kenya (Leikiji, Ol Jogi, and Ilmotiok) to discuss zoonotic diseases of bat origin, such as Ebola and Nipah virus, as well as risk mitigation techniques to protect their health and keep their communities safe. Students first watched a documentary film about zoonotic diseases meant to stimulate conversation.

Following a Question-and-Answer session, students viewed the mobile Outbreak Exhibit and talked about the importance of conserving bat populations while preventing disease transmission from wildlife to people.

In Guinea, PREDICT's community engagement and risk communication team worked closely with 27 primary schools to bring the *Living Safely with Bats* book and risk reduction messages to over 2,700 children. At the schools, PREDICT distributed 250 of the books to school directors. These books are being used in reading exercises and as a tool for child-to-child communication, along with their intended purpose for increasing awareness of zoonotic diseases, conservation, and the role of wildlife in health ecosystems.

Photo: PREDICT/Kenya "Outbreak" exhibit in Laikipia County

SUCCESS STORY

Strengthening National Capacity to Detect & Prevent Priority Zoonotic Diseases

SIERRA LEONE

Finding viruses before they find us

For the first time in West Africa, scientists discovered the deadly Marburg virus in five Egyptian rousette fruit bats in Sierra Leone. Marburg virus was co-discovered by scientists from two separate projects–the USAID PREDICT project and the US Centers for Disease Control and Prevention project with Njala University.

The multiple diverse strains of the highly pathogenic Marburg virus were found in its natural fruit eating bat reservoir in several locations across the country, suggesting Marburg virus has been present in these bat colonies in Sierra Leone for many years. The Marburg virus was found in Egyptian rousette fruit bats who primarily feed on fruit–if infected, they can shed the virus in their saliva, urine, and feces. In light of the potential threat from this virus, PREDICT/Sierra Leone continues to emphasize how to reduce the risk of exposure and live safely with bats throughout communities in Sierra Leone, stressing the importance of bats as a keystone species for healthy ecosystems.

LIBERIA

Liberia reaches a healthy security milestone

In Liberia, the PREDICT team reached a major milestone this year with the successful identification of *Zaire ebolavirus* in an insectorivorous bat. This discovery is momentous because it is the first detection of *Zaire ebolavirus* in a bat in West Africa, providing important evidence that these bats may be a natural host for Ebola. Our findings and insights are helping target national surveillance and risk communication strategies and empowering local communities with the knowledge to prevent zoonotic disease spillover and spread.

In follow-up to the *Zaire ebolavirus* finding and in order to reinforce national laboratory capacity for detection of ebolaviruses, a Liberian scientist received training in advanced disease detection techniques at PREDICT's partner laboratory (Columbia University Mailman School of Public Health). As a result of PREDICT's engagement, Liberia has a trained and equipped wildlife surveillance team and a national laboratory with the capability to detect ebolaviruses and emerging viral threats, yielding tremendous value for strengthening national health security.

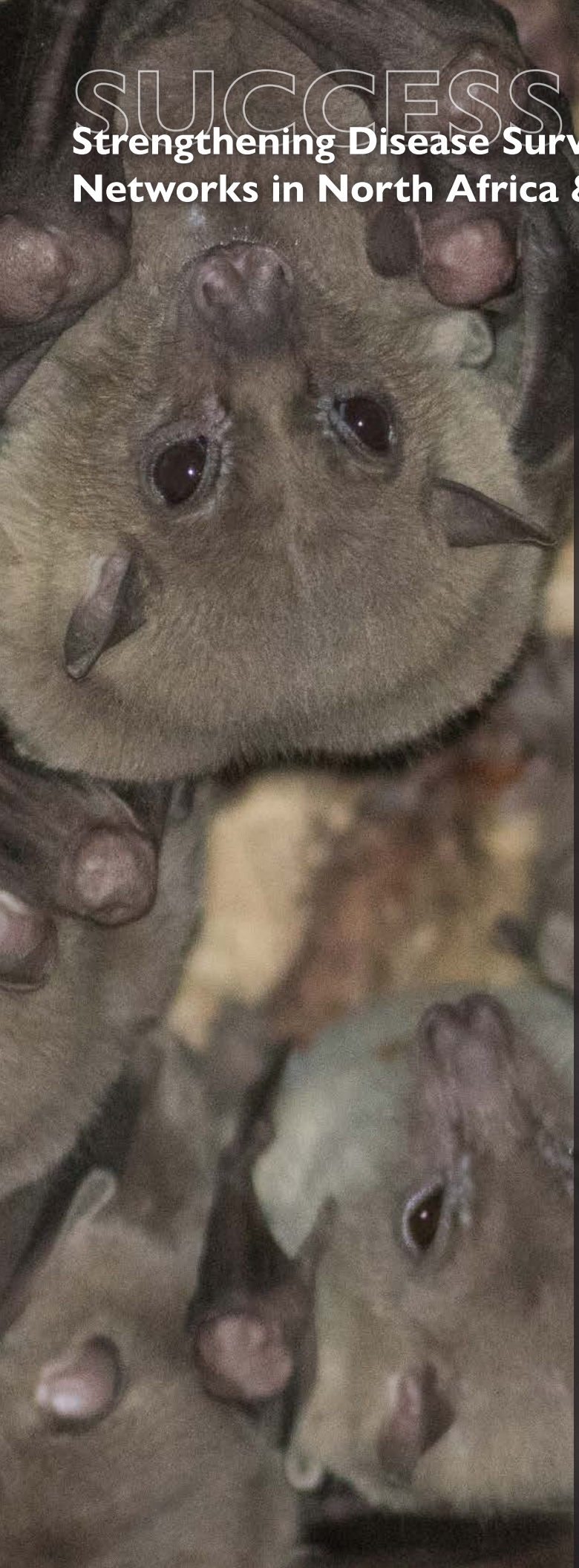
Ebola Host Project

PREDICT's Ebola Host Project, a regional effort across West Africa, is working to identify the animal host species of ebolaviruses. Recent discoveries in bats, which include a new ebolavirus (*Bombali ebolavirus*), *Zaire ebolavirus*, and Marburg virus, exemplify the mission of USAID's PREDICT Project, which aims to find viruses before they spillover into humans and cause economic catastrophes and devastating loss of life.

Photo: *Rousettus aegyptiacus* (credit: Getty Images)

SUCCESS STORY

Strengthening Disease Surveillance & Detection Networks in North Africa & the Middle East



Building the evidence base through new viral discoveries

Global disease surveillance initiatives for novel, emerging viruses are an essential component of pandemic prevention efforts. PREDICT's surveillance strategy is focused on high-risk transmission interfaces, where people and wildlife come into contact and where viruses have the potential to spillover from wild animals into people or their domestic animals. In Egypt, PREDICT collected samples from *Rousettus aegyptiacus* bats from an abandoned mudbrick house in a village in the Nile Delta region, then tested the samples for multiple viral families, including that of influenza viruses. As a result, the team not only discovered a new influenza virus, but the first and only characterization of this wild type bat influenza isolate. Interestingly, the virus was distinct from any previously discovered influenza A virus, suggesting that it is a novel H19N12 subtype.

This exciting finding was recently published in the January 2019 issue of the *Journal of Virology*: "Isolation and Characterization of a Distinct Influenza A Virus from Egyptian Bats."

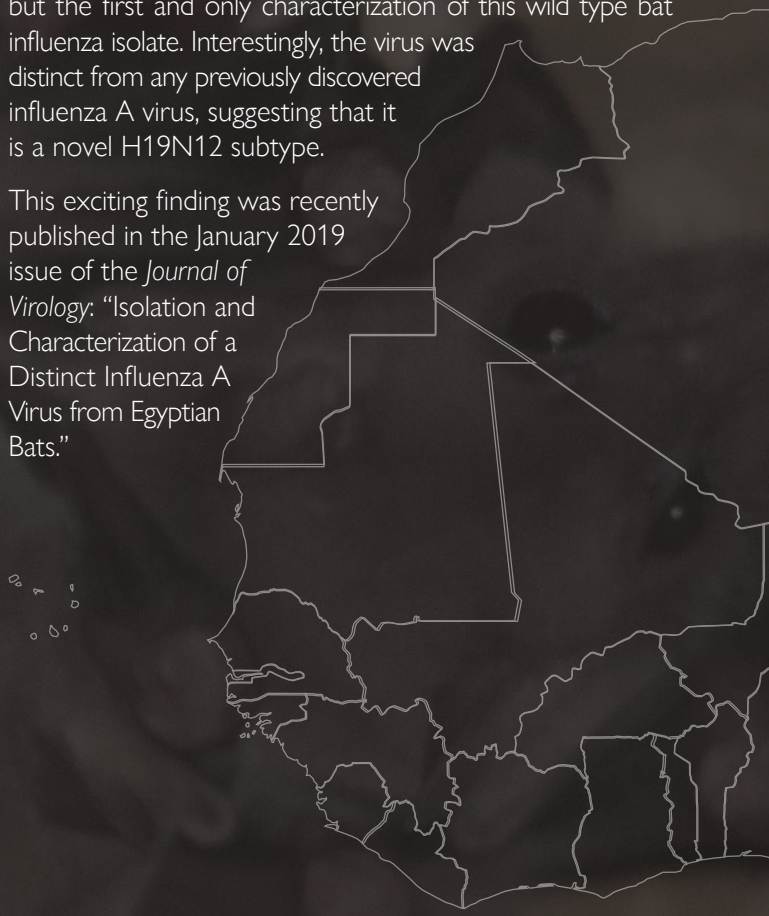
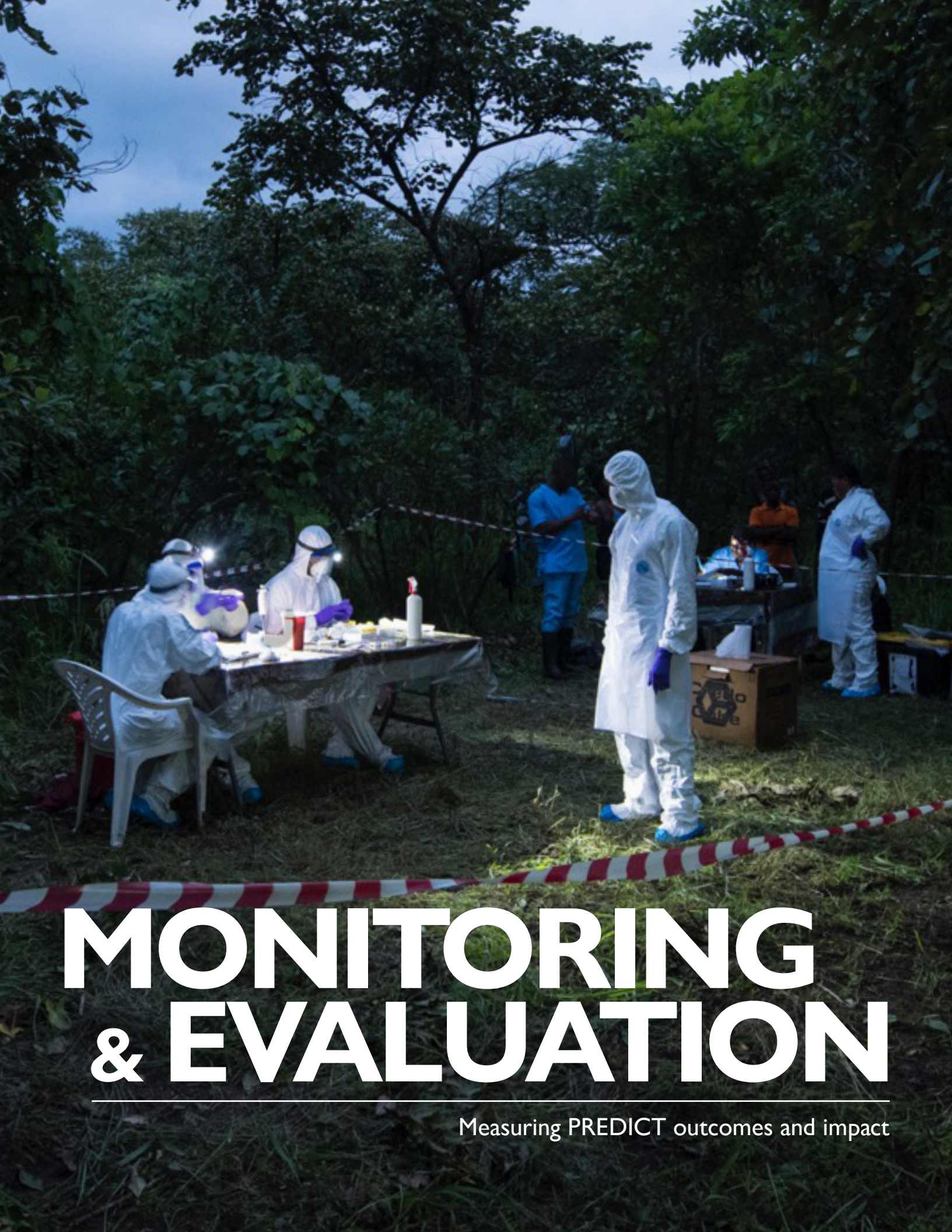


Photo: *Rousettus aegyptiacus* (credit: Minozig)

Improving regional health security

PREDICT works to optimize surveillance and detection protocols and strengthen capacities in national laboratory systems, and to enhance multi-sectoral and regional collaboration between labs for improved global health security. PREDICT continued to encourage collaboration between Egypt's National Research Centre's Center of Scientific Excellence for Influenza Viruses (our project lab in Egypt) and the Jordan University of Science and Technology (JUST – our lab in Jordan) through trainings, sample sharing, and testing of human samples. In 2017, the PREDICT/Egypt team traveled to Jordan for hands-on trainings in safe bat capture and sampling. In turn, the PREDICT/Jordan team assisted with safe and effective implementation of One Health surveillance in at-risk Jordanian communities. In addition, PREDICT lab teams worked together to better understand exposure to Middle East Respiratory Syndrome Coronavirus (MERS-CoV). In Egypt, 1,084 human samples were screened using serological assays for MERS-CoV-neutralizing antibodies via a serum microneutralization test. This allowed all of the serology tests from PREDICT/Egypt and Jordan teams to be directly compared, yielding regional insights on MERS exposure in the North Africa and Middle East regions.



MONITORING & EVALUATION

Measuring PREDICT outcomes and impact

PREDICT ACTIVITY	DEFINITION	MONITORING INDICATOR
Outbreak Response	Providing technical assistance with outbreak response if requested by the government and approved by USAID	Description of outbreaks supported; percentage of countries with improved capacity to conduct oubreak investigations
One Health Surveillance & Risk Characterization	Conducting animal and human sampling; conducting biological and/or behavioral data collection; collecting data on ecological and epidemiological factors associated with virus evolution, spillover, amplification, and/or spread; collecting data on animal-human contact for characterization of behavioral risk; prioritization and description of identified intervention points to inform development of risk mitigation approaches	Risk mitigation strategies recommended for implementation and/or scaling up; characterization of risk factors and/or interfaces associated with spillover, amplification and/or spread; intervention points prioritized for development of risk mitigation approaches
Modeling and Analytics	Development of tools to better understand the emergence of disease pathogens	Viral, bacterial, or other disease risk pathway models or maps developed and/or refined
Lab Strengthening: PREDICT Viral Family Screening	Laboratories have adequate infrastructure (facilities, lab equipment, staff, etc.) and sufficient training to conduct consensus PCR (cPCR) testing for the minimum four viral families (corona-, paramyxo-, influenza-, filo-) using PREDICT protocols and can perform, or have support to perform, cloning and sequeuncing to confirm PCR positives and to identify the virus present	Percentage of labs improving quality assurance and safety procedures; percentage of labs able to perform EPT2/GHSA prioritized testing and number of tests performed

Photo: PREDICT/Sierra Leone team setting up field lab station (credit: Simon Townsley)

PREDICT ACTIVITY	DEFINITION	MONITORING INDICATOR
Workforce Development: Training and Materials Developed	Personnel and/or students participating in the following types of trainings; Field Sampling, Information Management, Laboratory Techniques and Assay Development, and Risk Characterization	Number of faculty members that received One Health training or professional development; number of future professionals trained; number of One Health fellows placed; number of current professionals trained
Workforce Development: Local Capacity	PREDICT training and employment of local or regional staff members in host countries	Total number of in-country staff who are from the host country or region
Advancement & Improvement of One Health practices & policy	Development of One Health resources (including guidelines, technical protocols, standard operating procedures, standardized data collection instruments and protocols, and instructional tools and manuals for implementing risk mitigation recommendations) to provide evidence-based guidance on the operationalization and/or implementation of One Health principles and approaches; and inform policy change through evidence based solutions	Description of application of One Health approaches in the workforce; description of national/regional coordination mechanisms showing improved capacity; description of global, regional or country strategies under implementation; list of educational materials developed; tools developed for implementaiton and operationalization; evidence-based informational resources developed, including policy briefs, research papers, situational analysis/risk asssessment; and zoonotic prioritization resources

Photo: Children in Kenya learning about *Living Safely with Bats* (credit: PREDICT/Kenya)

2018-2019

ONE HEALTH TOOLS & RESOURCES

78 Educational & evidence-based materials developed

ONE HEALTH STRENGTHENING

15 Countries coordinating community One Health events

LAB STRENGTHENING

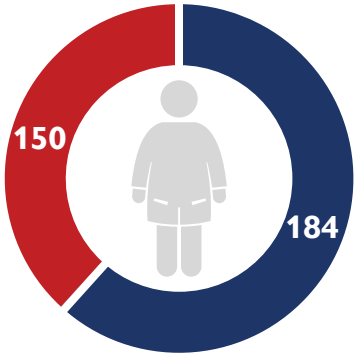
790K Tests performed

47 Labs able to perform PREDICT viral family testing

RISK MODELS & MAPS

34 Models or maps developed, refined, analyzed & described

ONE HEALTH WORKFORCE CAPACITY



RISK FACTORS & RISK INTERFACES

49 Risk factors & risk interfaces characterized since the beginning of PREDICT-2 in 2014

INTERVENTIONS

24 Intervention points prioritized to inform the development of risk mitigation approaches

Photo: Poultry and duck farm in Tanzania (credit: Brooke Genovese)

GLOBAL REPORT

One Health approach to creating a world safe & secure from infectious disease

CAPACITY STRENGTHENING

Since 2009, PREDICT has trained over 5,000 One Health Professionals in Africa, Asia and Latin America

PREDICT-2 uses an integrated approach to train personnel in One Health skills necessary for field surveillance activities, laboratory testing, outbreak preparedness, and development of risk reduction strategies and interventions. Emerging viruses have the potential to spillover and cross borders; therefore, it is also essential to build a network of international health professionals who can detect, respond to, and prevent health threats.

Since October 2014, PREDICT-2 has engaged in over 28 countries in Asia and Africa to foster leadership and transdisciplinary thinking in the next generation of One Health professionals, strengthening skills and capacities of more than 3,500 people through 20,000 individual training events in topics such as biosafety, cold chain management, emergency preparedness, field sampling, behavioral risk investigations, and disease detection. To enhance global health security, PREDICT-2 continued to train future and current One Health professionals through 'on the job' trainings and workshops. Among these professionals, PREDICT has trained over 300 university students and 1,000 project staff in zoonotic disease surveillance and disease detection skills, a major contribution to the long-term capabilities of national health systems.

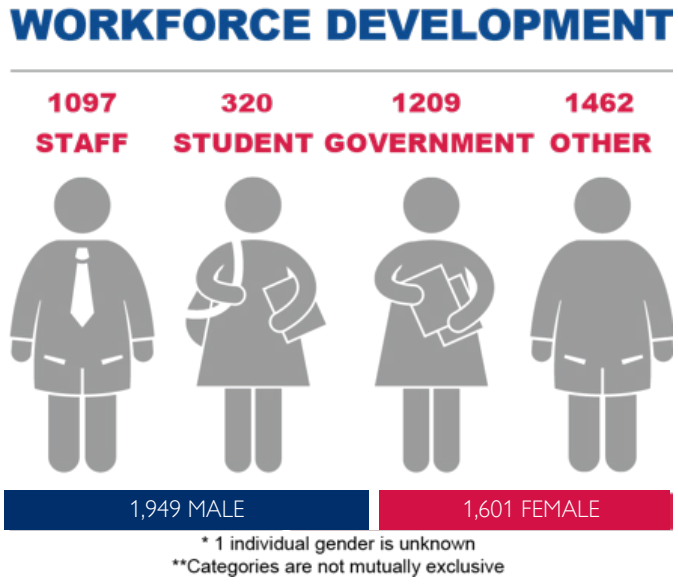


FIGURE 1. Since 2014, PREDICT-2 has trained over 3,500 individuals in One Health surveillance and disease detection in over 28 countries. Trained individuals include PREDICT staff, university students, government officials and others.

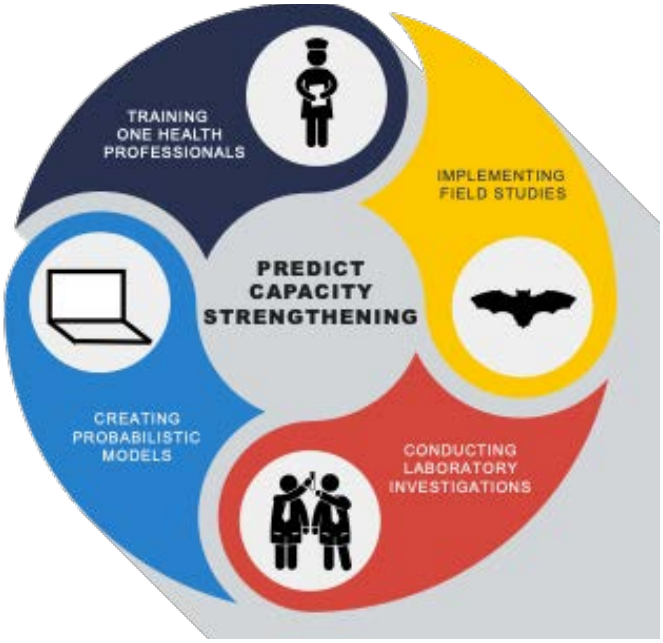


FIGURE 2. PREDICT-2 uses an integrated approach to train personnel in One Health competencies that enable field surveillance activities, laboratory testing for priority zoonotic diseases and other emerging threats, outbreak assistance, and informed behavior change that improves our understanding of zoonotic disease risks at key wildlife-livestock-human interfaces where spillover events may occur.

Building national capacity for zoonotic disease surveillance

Since the inception of PREDICT, the project has focused on enhancing One Health surveillance and laboratory diagnostic capacity in hot spot regions in Asia and Africa, training over 1,200 government officials in the core skills required to detect, respond to, and prevent zoonotic disease threats. In Bangladesh, PREDICT has been providing support and training for the multidisciplinary government outbreak response team, which independently led a wildlife outbreak response in December 2018 (see Success Stories section for details).

We continued to build key partnerships within and across active countries, as exemplified through collaborations with universities, ministries, and international organizations in Asia and Africa. This year, PREDICT/Senegal organized an innovative two-day outbreak simulation exercise on detection and response to an Ebola Virus outbreak for government officials, which resulted in discussions among human, animal, and environmental health sectors emphasizing the importance of collaboration among ministries to prevent and respond to emerging pandemic threats.

FIGURE 3. PREDICT/Senegal hosted a two-day simulation exercise on detection and response to an Ebola Virus outbreak. The simulation hosted over 40 participants from seven different ministries.

In Jordan, our PREDICT team played a critical role in the development of the molecular and virology laboratory at Jordan University of Science and Technology helping enhance JUST capabilities in molecular diagnostics. For example, in November 2018, there was a die-off and millions of dead fish were found along nearby rivers. Samples were sent to the JUST laboratory, and the team detected an emerging herpes virus called koi herpes.

FIGURE 4. PREDICT/Jordan strengthens capacity in laboratory techniques by training graduate students who work as part-time research assistants. Master's student Ola Abebneh demonstrates laboratory techniques at the JUST Molecular and Virology Lab.

Developing innovative training & outreach strategies

Capacity building activities often take place in a traditional classroom, but technical skills for health professionals are best learned in the field or lab through instruction and hands-on training. Through PREDICT-2, a variety of training approaches have been utilized, from online trainings to face-to-face workshops.

In Cambodia and beyond, PREDICT performs aligned surveillance with the participation of government partners, university students, and local authorities, including district and village veterinarians and nurses. Our team in Cambodia also provides experiential training to university students, who serve as interns in the field and project lab to practice and perfect their skills.

FIGURE 5. PREDICT/Cambodia is strengthening wildlife surveillance by working with university students and interns in the classroom and in the field. These hands-on experiences with professional mentors are valuable opportunities for students to apply knowledge and help strengthen the workforce for zoonotic disease surveillance.

Similarly, in Kenya, PREDICT launched an innovative strategy for raising community awareness of the One Health approach and risks of zoonotic diseases through the use of the Smithsonian Institute National Museum of Natural History's "Outbreak" panels. The panels were showcased in the communities and provided a platform for community members to engage in dialogue and role-play to learn and explore ways to prevent, detect, and control diseases at high-risk human-animal-environment interfaces.

FIGURE 6. PREDICT/Kenya showcases "Outbreak" panels at a One Health training, an innovative approach to increasing community awareness of zoonotic diseases and for learning about zoonotic disease prevention, detection, and control.

A One Health learning library for students & professionals

To encourage sharing of the knowledge and skills essential for safe and effective One Health surveillance, detection, and characterization of zoonotic disease threats, PREDICT's training materials, protocols, and e-book resources are freely available to the public (in English and French) at:

www.publications.predict.global

Publicly available guides & protocols

Biosafety, Cold Chain and Emergency Preparedness Resources

- Basic Laboratory Safety
- Biosafety & PPE Use
- Emergency Preparedness
- Implementing Cold Chain for Safe Sample Transport & Storage
- Packing & Shipping Biological Samples

One Health Surveillance & Field Sampling Guides

- Avian Sampling Methods
- Bat Sampling Methods
- Bushmeat Sampling Methods
- Livestock Sampling Methods
- Non-Human Primate Sampling Methods
- Rodent Sampling Methods
- Safe Animal Capture & Sampling
- Small Carnivore Sampling Methods

Behavioral Risk & Qualitative Research Guides

- Qualitative Research: Introduction & Observational Research Methods
- Qualitative Research: Focus Groups, Ethnographic Interviews & Data Analysis

Photo: *Macaca mulatta* in Nepal (credit: Pranav Pandit)

ONE HEALTH SURVEILLANCE:
Characterizing Biological & Ecological Risk

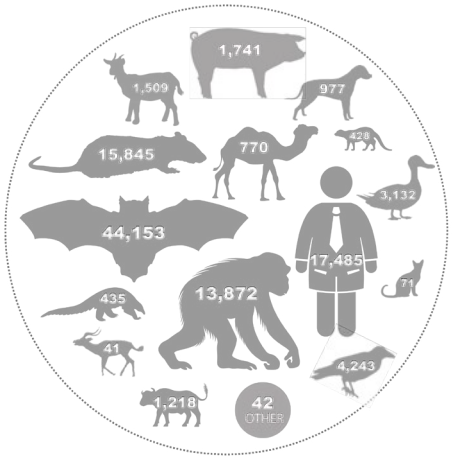
Overview

We completed implementation of our overall One Health surveillance strategy for animals and humans, in coordination with USAID and Emerging Pandemic Threats-2 (EPT-2) partners, to detect viruses in animals and humans and to characterize biological and ecological risk. Surveillance activities focused on a concurrent surveillance strategy for detection of viral sharing and spillover as a result of close proximity interactions, or effective contact, between wildlife shedding viruses and susceptible people (and domestic species where relevant). For human surveillance, sampling targeted people with high-risk occupations at concurrent sampling sites for animals, as well as acutely ill patients year-round at clinic and hospitals within the catchment area of concurrent sites.

At the PREDICT Semi-annual Meeting in November 2018, we reviewed surveillance progress and accomplishments to date and strategized successful completion of sampling and field activities with USAID and global and regional leads. We outlined the transition to post-sampling activities, including supporting data cleaning at the country and cross-partner level, preparation of data for analyses, and discussion of risk characterization. Additionally, we finalized how serology testing will be utilized to complement PCR testing already underway to provide a more complete surveillance assessment.

Targeted monitoring for zoonotic viruses with pandemic potential at specific high-risk interfaces

PREDICT-2 has sampled over 88,000 animals and 17,000 people since the start of project activities in October 2014. Years 1-2 involved coordination of a multitude of required activities before sampling began in each country, including engagement of local partners and stakeholders, obtaining local and institutional permits for animal and human sampling, and staff training. Over the past year, field activities substantially ramped up with respect to sampling efficiency across wildlife, domestic animals, and humans (Figure 1). Sampling activities were completed in the majority of participating countries by the end of Year 4 (September 30, 2018), and remaining sample collection events were completed by the end of January 2019. As sample collection wrapped up, efforts were transitioned to reviewing data, standardizing key data fields that accepted write-in responses, and preparing data for analyses.



Wildlife

PREDICT made a substantial effort towards sampling targeted wildlife species, primarily bats, rodents, and non-human primates, at high-risk interfaces for zoonotic spillover and spread. Wildlife sampling activities at high-risk interfaces were completed in all 28 PREDICT-engagement countries, which include Bangladesh, Cambodia, Cameroon, China, Côte d'Ivoire, Democratic Republic of Congo, Egypt, Ethiopia, Ghana, Guinea, India, Indonesia, Jordan, Kenya, Lao PDR, Liberia, Malaysia, Mongolia, Myanmar, Nepal, Republic of Congo, Rwanda, Senegal, Sierra Leone, Tanzania, Thailand, Uganda, and Viet Nam.

Livestock

PREDICT coordinated with FAO on planning and sampling livestock at sites designated for concurrent and triangulated surveillance wherever possible.

Concurrent livestock sampling activities have been directly supported by FAO in Bangladesh, Cambodia, Indonesia, Lao PDR, Myanmar, Thailand, and Viet Nam. Together with PREDICT teams, FAO sampled livestock in the same locations as wildlife (and humans where possible) in Egypt, Jordan, Nepal, and Tanzania. To date, PREDICT has completed additional livestock sampling in the Democratic Republic of Congo, Guinea, Kenya, Malaysia, Sierra Leone, and Uganda. Due to FAO priorities, livestock sampling was not conducted in Cameroon, China, Côte d'Ivoire, Ethiopia, Ghana, India, Liberia, Mongolia, Republic of Congo, Rwanda, and Senegal.

Humans

Human biological sampling and risk characterization surveys using PREDICT's human questionnaire were completed in high-risk communities in 23 targeted countries: Bangladesh, Cambodia, Cameroon, China, Côte d'Ivoire, Democratic Republic of Congo, Egypt, Ethiopia, Ghana, India, Indonesia, Jordan, Kenya, Lao PDR, Malaysia, Myanmar, Nepal, Rwanda, Senegal, Tanzania, Thailand, Uganda, and Viet Nam.

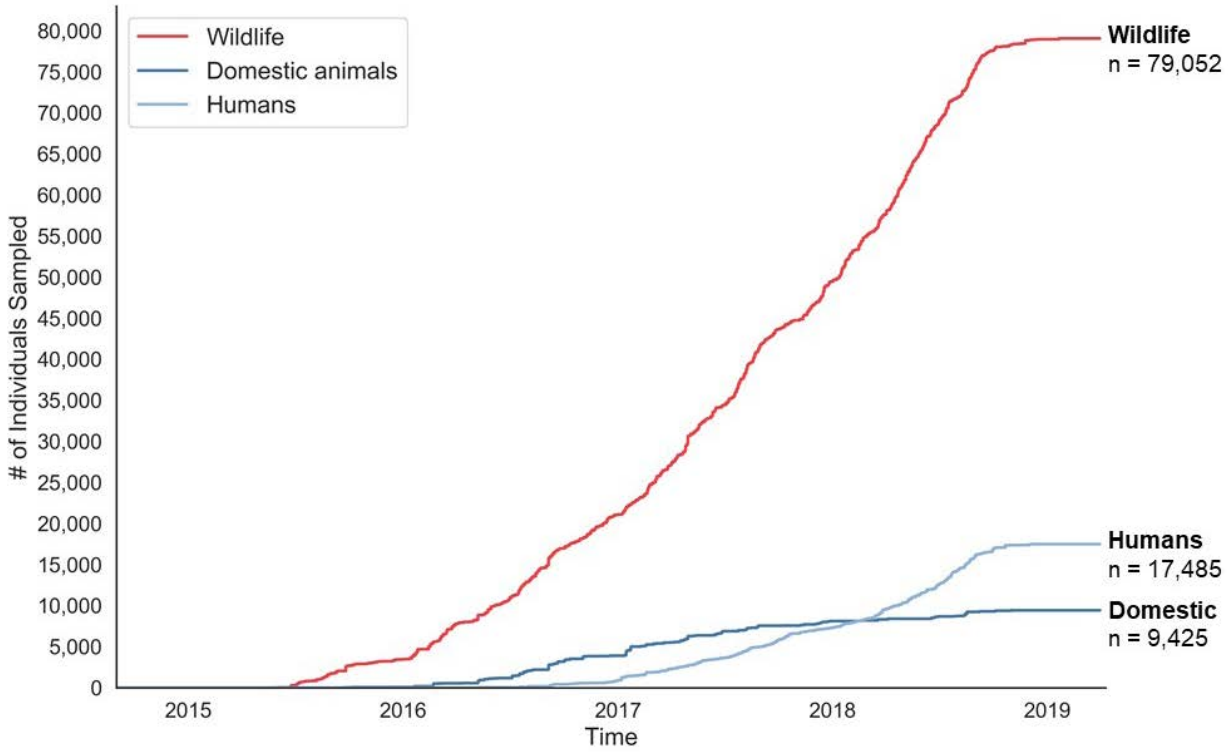


FIGURE 1. Number of individual wildlife, domestic animals and humans sampled.

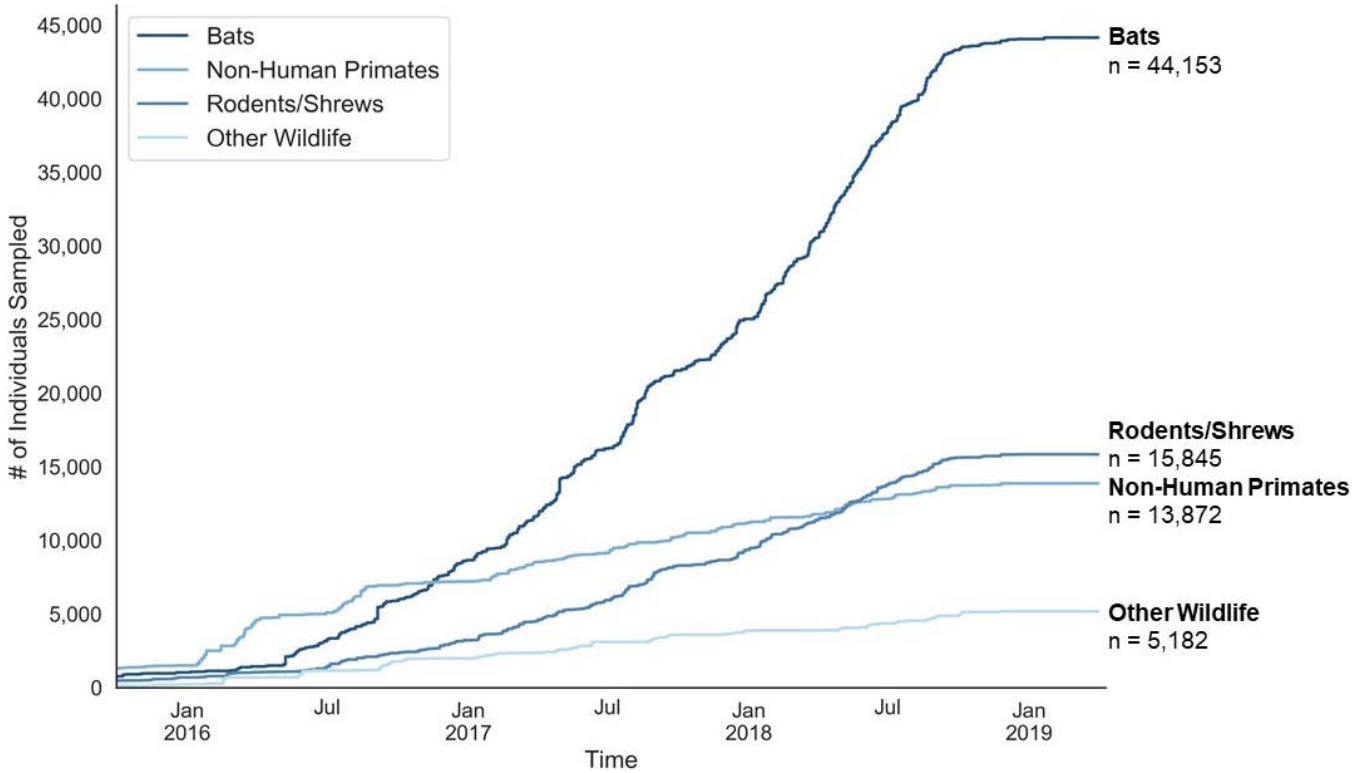


FIGURE 2. Number of individual wild animals sampled overall, by taxonomic group.*
**Depicts animals with data entered into the Emerging Infectious Disease Information Technology Hub (EIDITH), PREDICT's information and data management system.*

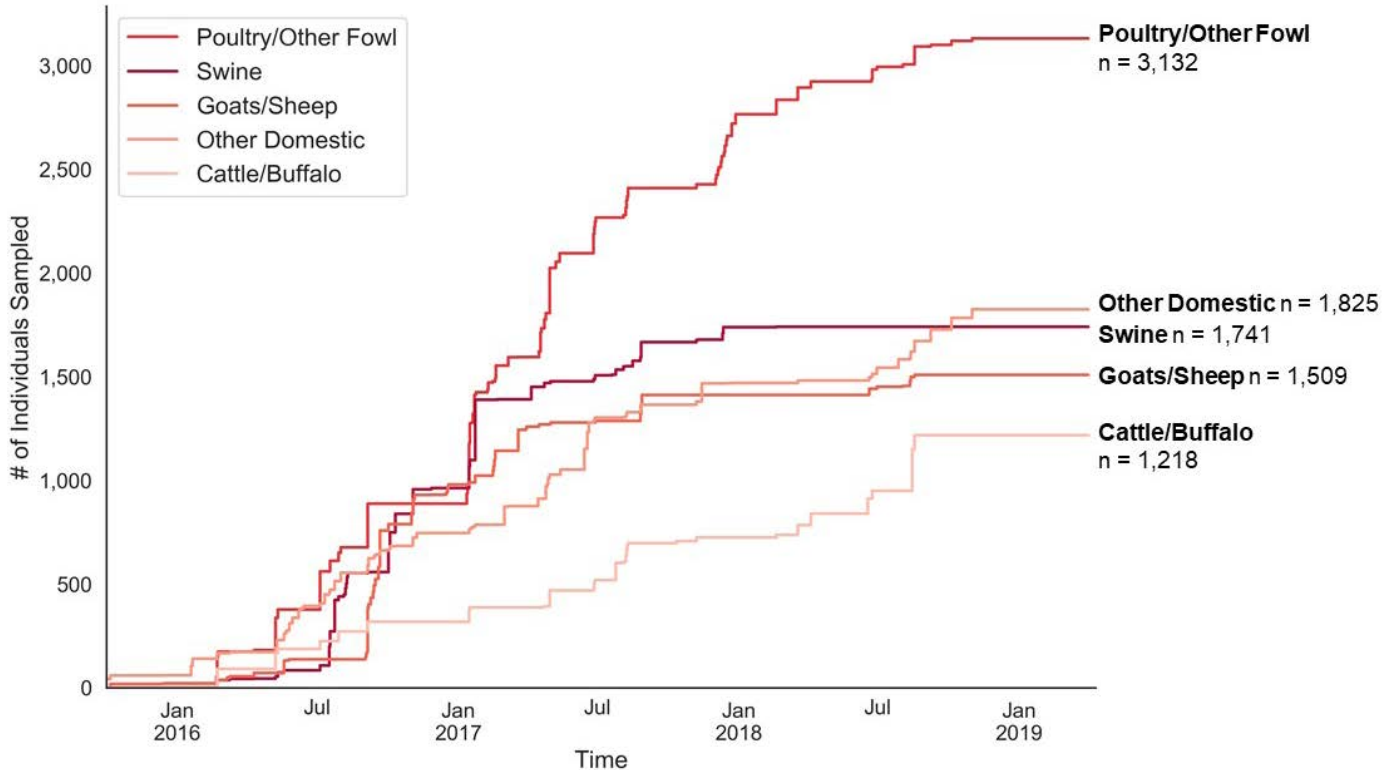


FIGURE 3. Number of individual domestic animals sampled overall, by taxonomic group.*
**Depicts animals with data in EIDITH.*

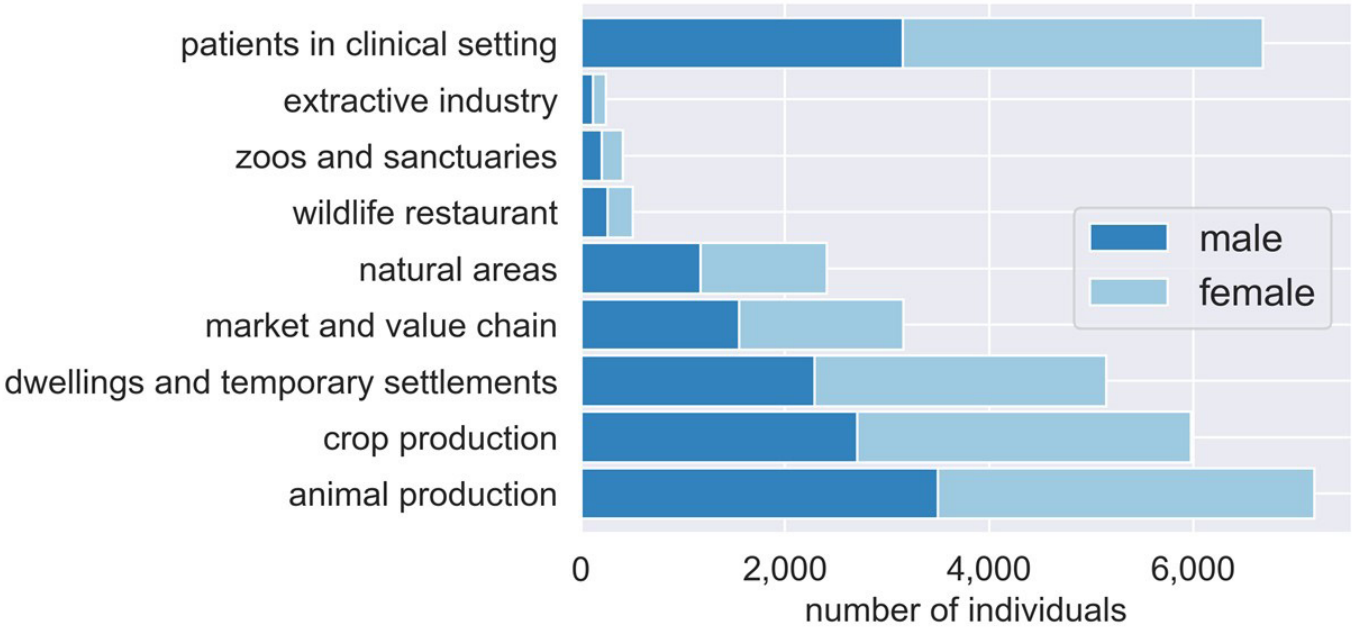


FIGURE 4. High-risk interface modules completed by individuals sampled in the community or patient clinical setting, aggregated by gender.*
**Many individuals sampled were identified with more than one disease transmission interface.*

CHARACTERIZING BEHAVIORAL RISK

PREDICT's behavioral risk activities aim to 1) collect data to better understand the human drivers of viral emergence, transmission, and spread, and 2) use evidence to inform the development of potential population or policy-level intervention strategies to reduce the spillover, amplification, and spread of zoonotic viruses and other emerging threats.

Highlights

- 739 professionals (46% women) in 29 countries trained on a variety of topics relevant to behavioral risk investigations.
- 9 tools established or refined to enhance the rigor of mixed-method behavioral risk characterization and the development of intervention recommendations.
- Over 1,000 ethnographic interviews and 100 focus groups (inclusive of over 900 participants) conducted.
- More than 19,000 quantitative behavioral questionnaires completed with community members and patients.
- More than 100 downloads of the *Living Safely with Bats* behavior change and risk communication picture book by community leaders, members, students, and individuals who work in academia or research, public health, animal health, NGOs, elementary schools, US government agencies, development, communications, museum libraries, and bat conservation. Successful endorsement of the behavior change book during its initial rollout in West Africa along with interest from the broader PREDICT consortium led to a broader adaptation and development for use in Asia partner countries (Figure 1).

FIGURE 1. PREDICT's Living Safely with Bats behavior change and risk communication picture book, adapted for the South and Southeast Asia region.

Successes

Strengthening capacity for behavioral risk investigations in 28 countries

FIGURE 2. Trainings include both remote and in-person events, as well as cross-team trainings to build regional capacity.

Standardizing approaches for investigating human behavioral risks

PREDICT continued to standardize and refine behavioral risk protocols, frameworks, and data investigation tools to improve scientific rigor within data analyses and interpretation.

- A Data Analysis Report was prepared that provides a visually engaging way to digest the information from the ecological, biological, and behavioral risk surveillance questionnaires. This report allows the data to be rapidly compared across each site for each country. With this new tool, country team members and technical team members are able to quickly conceptualize the differences between reported behaviors and contacts in country sites. The Data Analysis Report uses heatmaps to represent varied animal contacts by priority taxa overall and by key demographic characteristics. User-friendly heatmaps, such as the one featured from Indonesia (Figure 3), will assist country teams in exploring the data by visualizing trends as they work to develop evidence-based intervention recommendations.
- Data analysis planning resources were developed—including a framework and prototype to support analysis planning across all country-level behavioral risk teams and across consortium technical teams. In addition, an inventory of analysis themes of interest to country teams was established, helping coordinate data analysis for development of holistic, multidisciplinary One Health intervention recommendations.

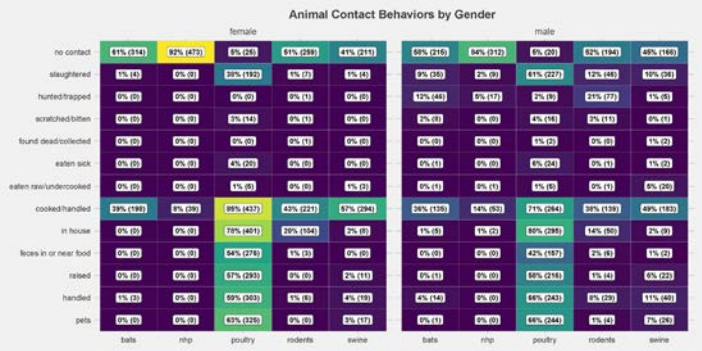


FIGURE 3. Behavioral Risk heatmap from Indonesia of the responses of the ecological, biological and behavioral risk surveillance questionnaires, by gender for various contact types by priority animal taxa.

Identifying Potential Intervention Points

The **Intervention Development Tool**—created to assemble the risk and protective factors relevant to knowledge/beliefs, attitudes, skills, and behaviors—has been implemented. The tool is used to capture both protective and risky factors as they relate to behavior and incorporates relevant summaries with supporting data sourced from ethnographic interviews and focus group discussions. The end-goal logic model for behavioral change, which will incorporate these findings, can be seen in Figure 4.

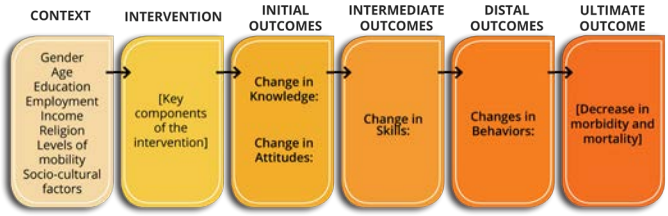


FIGURE 4. PREDICT's logic model for behavior change.

Deep Dive Investigations. Preliminary analyses of project data revealed that bat-related interfaces warrant particular attention, given the connection between bats and epidemics (such as in the case of SARS and Ebola). PREDICT has detected numerous viruses in bats at high-risk interfaces, including filoviruses, coronaviruses, paramyxoviruses, and influenza viruses, further supporting the need to conduct in-depth behavioral investigations at human-animal contact interfaces.

Our work exploring zoonotic disease risk and behaviors at human-animal interfaces, such as animal markets and value chains, also warrants extensive examination. PREDICT continued to explore several priority deep dive topics (Figure 5) that we identified as particularly critical for in-depth investigation. Early insights into intervention recommendations have been drafted across six countries (nine deep dive topics).

FIGURE 5. Behavioral risk deep dive topics under investigation by PREDICT technical teams.

Collaboration across Objective Teams. The PREDICT Modeling and Analytics (M&A) technical team is leading the implementation of modeling efforts referred to as 'IMPACTs' (Intervention Modeling Projects ACross Teams). The IMPACTs, some of which are focused on behavioral questions around human-bat interactions, are designed to output modeling results that can be integrated into the development of intervention recommendations for each of PREDICT's deep dive topics.

Working with the Surveillance and M&A technical teams has allowed for visually engaging analyses of the quantitative behavioral data (Figure 6).

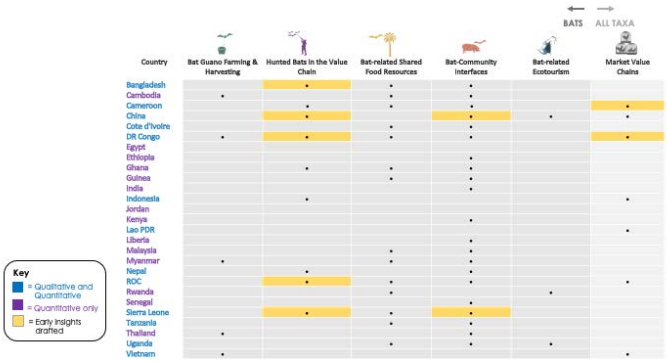


FIGURE 6. The multitude of ways that PREDICT-enrolled participants who completed the questionnaire experience contact with animals.

Select PREDICT Behavioral Risk Products

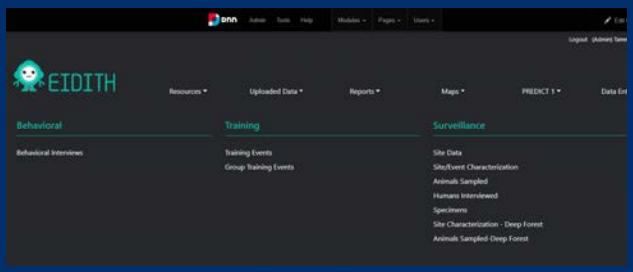
- 11 training decks to support capacity-building sustainability
- Data analysis planning resources
- Questionnaire analysis report
- Coding clarification log
- Questionnaire analysis matrix
- Real-time Interim Data Review (IDR) report
- Maps of behavioral data
- Intervention development tool
- Behavior change and risk communication resource *Living Safely with Bats* adapted to multiple contexts and translated in several languages

STRENGTHENING ONE HEALTH DATA PLATFORMS

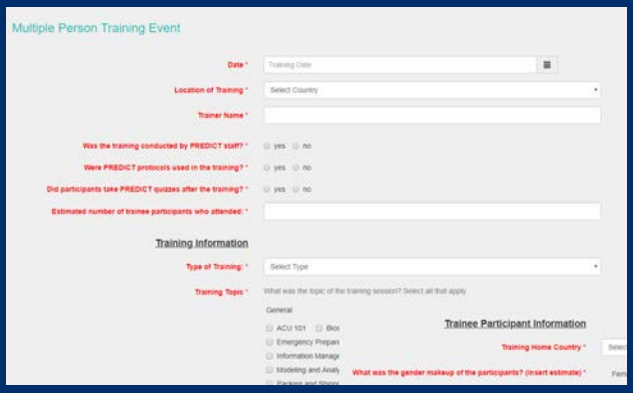
EIDITH

The Emerging Infectious Disease Information and Technology Hub (EIDITH) is the centerpiece of PREDICT's One Health data and knowledge management platform. Through EIDITH, One Health surveillance and lab data are captured from the field by apps and pushed to our secured servers for data cleaning and validation.

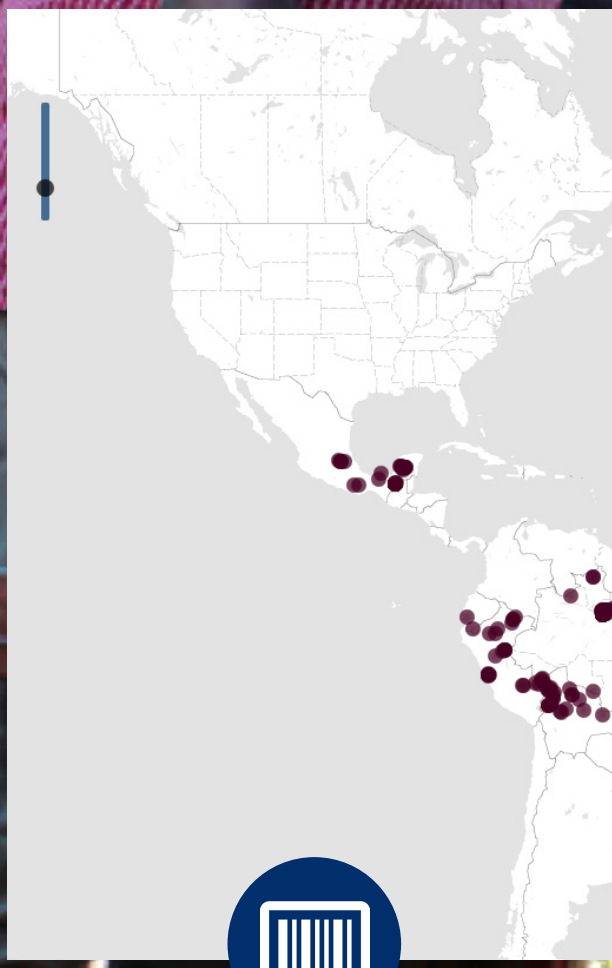
An EIDITH application for host species identification and DNA barcode results.



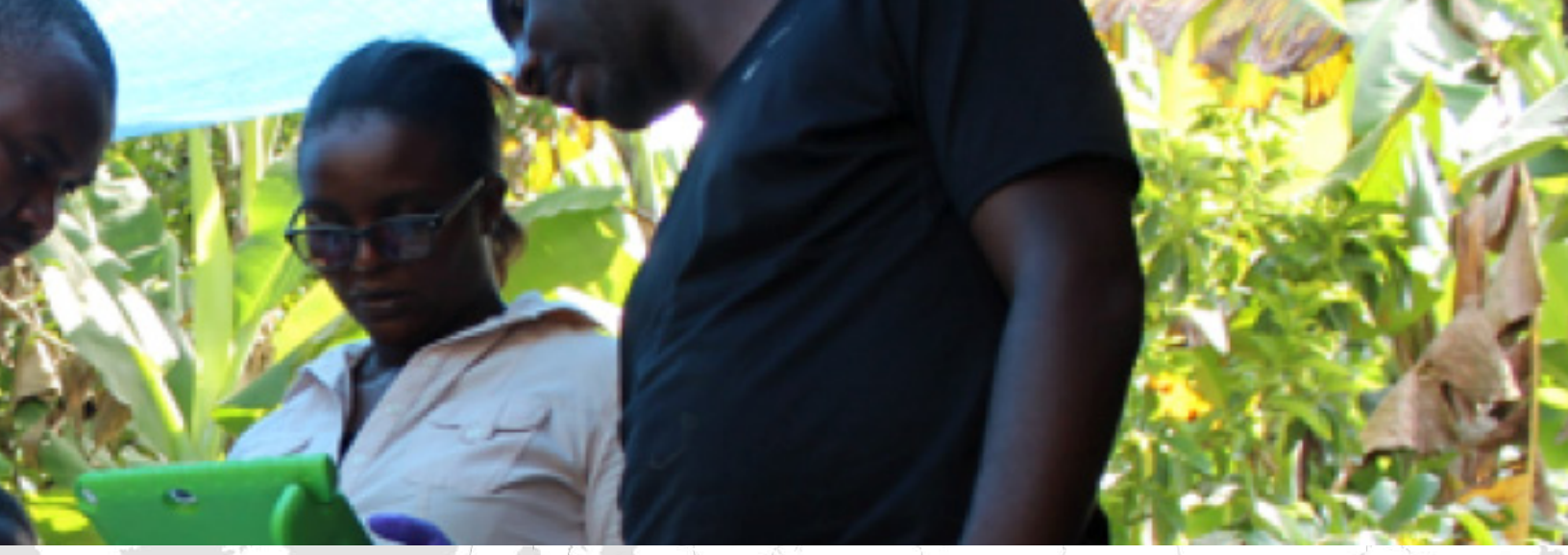
EIDITH's new menu system for improved site navigation.

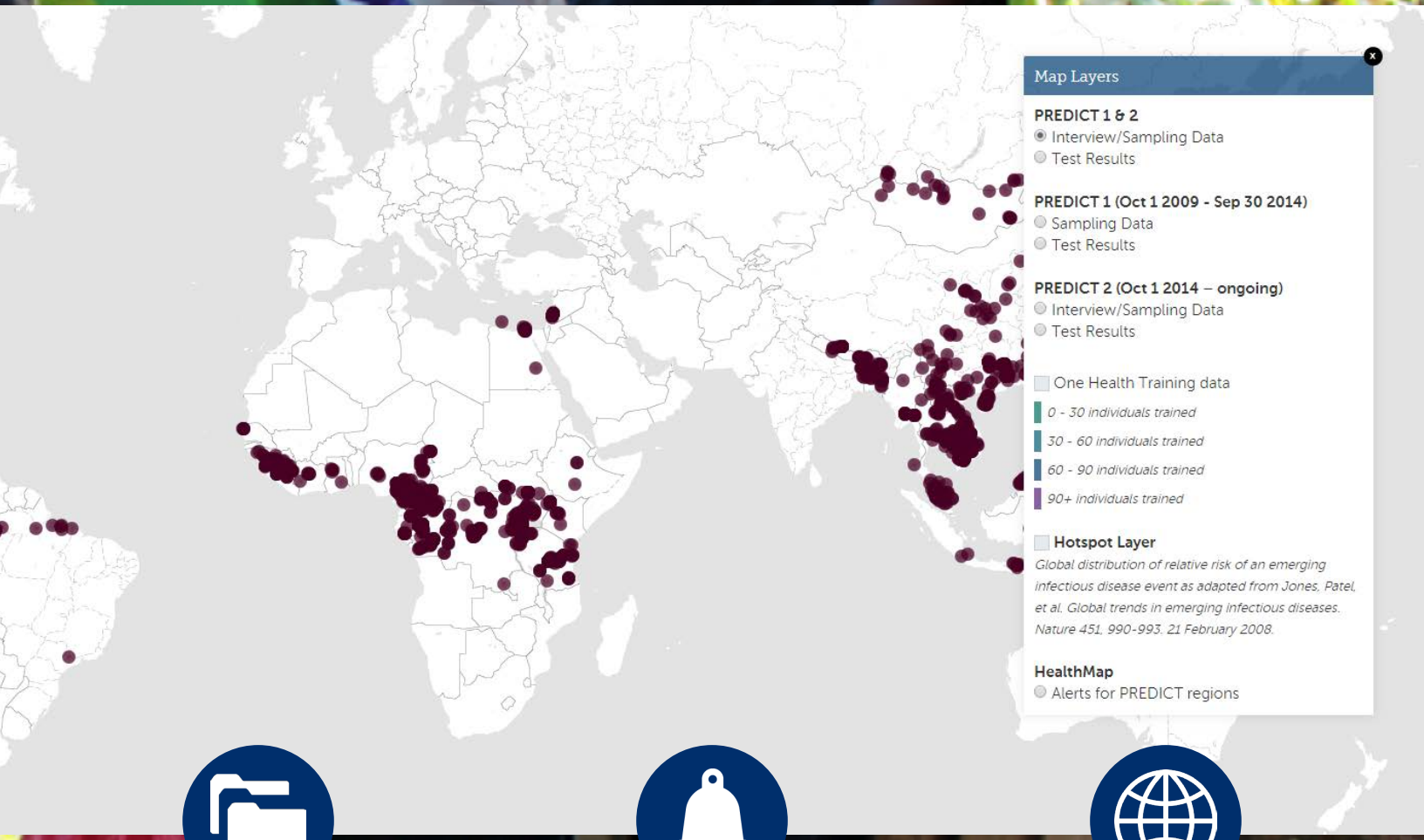


EIDITH training application form for multiple-person training data.



EIDITH has upgraded the animal identification (barcoding) test results module, improving the accuracy of species data, which is critical for the conservation community.





EIDITH enables reporting to PREDICT partners, USAID, and host country governments, pulling data from our servers into customized data and information summaries that include reports on viral findings for government review and approval for public release.

EIDITH is home to PREDICT's training tracking system, where our teams can monitor trainee status, receive notifications on expired or refresher trainings, and view One Health competencies gained through our capacity strengthening program.

EIDITH also exports data that are approved for public release to HealthMap, PREDICT's home for interactive training, surveillance, and test result data. The site, **www.data.predict.global** is updated every 24 hours and powers visualization and analysis of data for the entire life of the project.

Photo: Grace Mwangoka using EIDITH on a tablet (credit: PREDICT/Tanzania)

VIRAL DETECTION & LABORATORY IMPLEMENTATION

Laboratory capacity building

PREDICT continued to improve disease detection capabilities in 63 laboratories, targeted for training and testing across five priority viral families (corona, paramyxo, filo, influenza, and flaviviruses) known to cause zoonotic disease in humans and that are considered pandemic threats. There are now 47 labs testing for one or more priority viral families across Asia and Africa.

During this period, 19 labs gained step-wise increases in detection capacity (Figure 1): 10 gained a one-step increase, 8 gained a two-step increase, and one advanced three steps. As a result, one lab began testing for the first time, an additional lab produced preliminary results for the first time, and 17 labs submitted sequence results for interpretation.

Results reporting also improved, and viral findings have been approved for public release by host country governments in 22 countries. Results reports were prepared for 13 countries and shared with government partners (or will be shared soon). All government-approved results are available on our public site: **www.data.predict.global**.

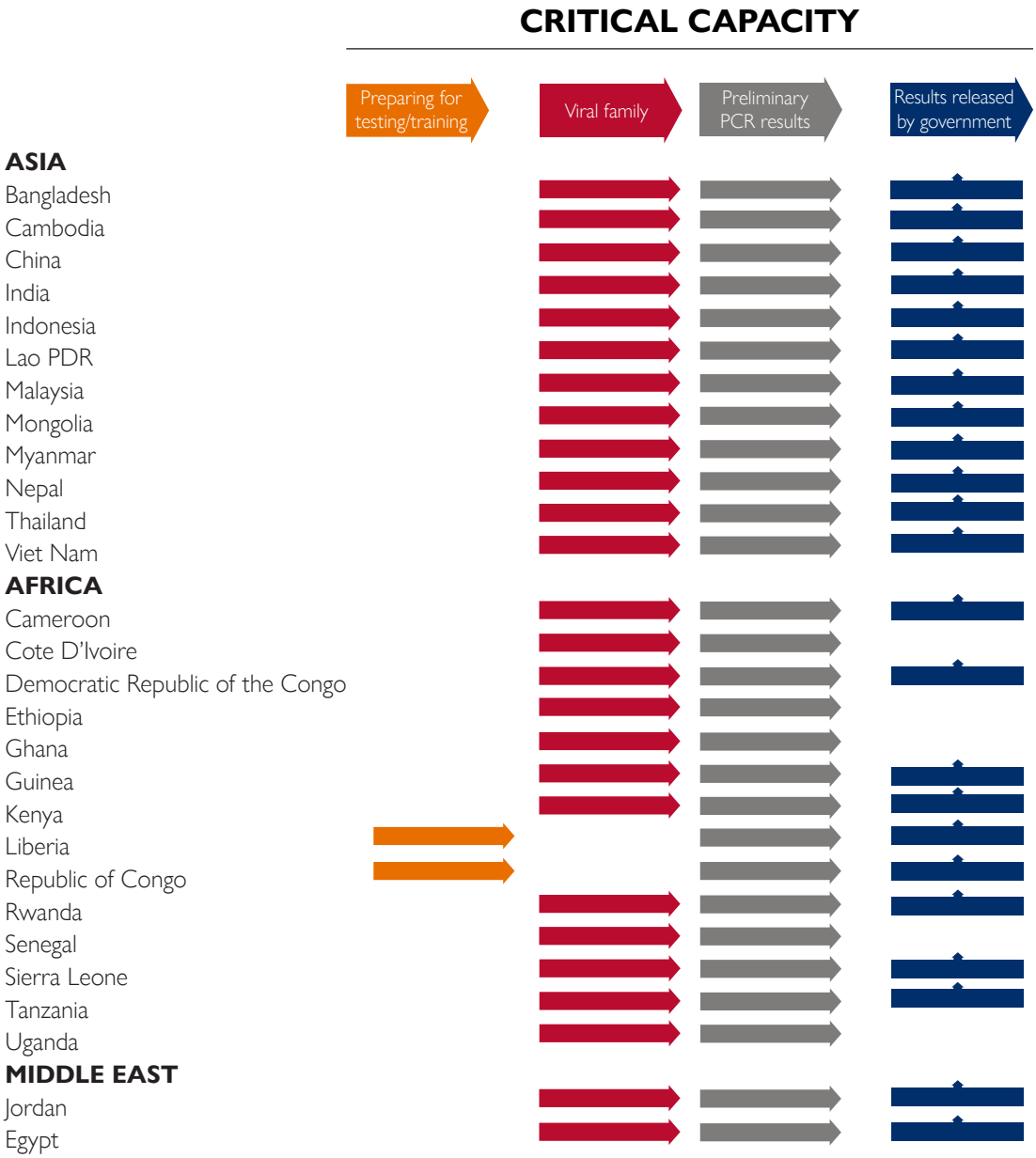


FIGURE 1. Major milestones and laboratory capacity gains toward viral detection

FIGURE 2. Bode Shobayo, deputy director for research at the National Public Health Institute of Liberia, visits the Center for Infection and Immunity (CII) at Columbia University. He was there to help with screening of Ebola Host Project samples collected from bats in Liberia and for training in advanced diagnostic platforms, including VirCapSeq and Serochip. While at the CII, Mr. Shobayo also participated in several capacity strengthening academic programs, including the weekly journal club in which he presented a study on filoviruses in China.

Testing progress

We are in the final stages of testing and data entry for the current five-year period. A side-by-side comparison shows that we tested more individuals in PREDICT-2 than in PREDICT-1, surpassing PREDICT-1 numbers in Year 2 (Figure 3). The majority of samples tested were from bats, humans, and rodents (Figure 4).

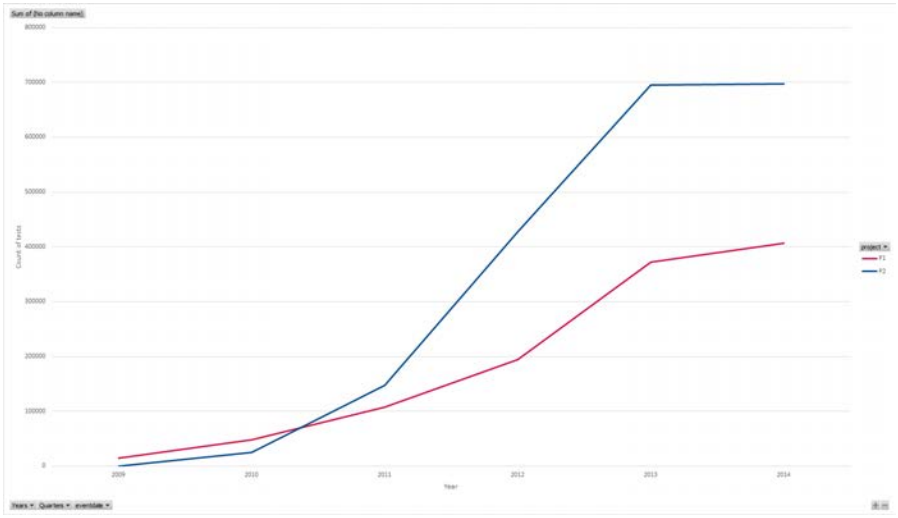


FIGURE 3. Total number of individuals tested in PREDICT-1 (red line) and PREDICT-2 (blue line).

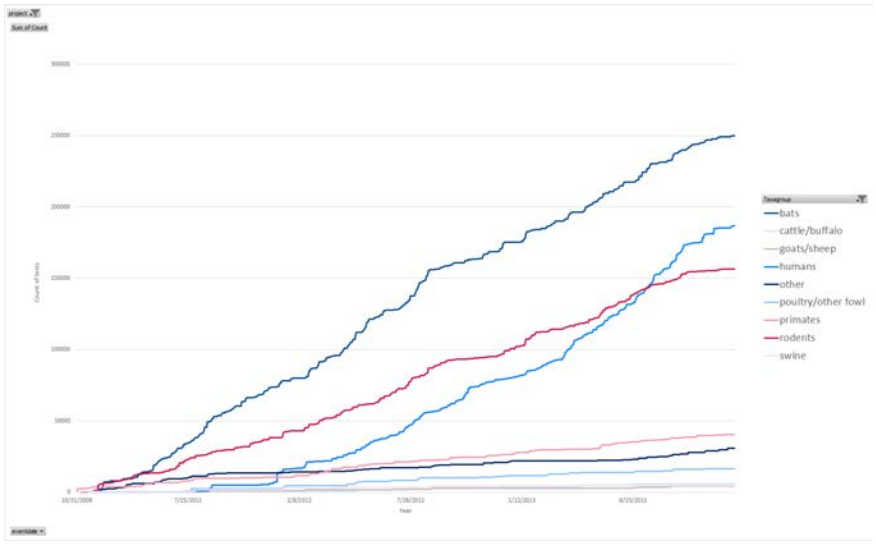


FIGURE 4. Total number of individuals tested to date, broken out by taxa.

PREDICT viral interpretation results

Viral family	# of known viruses found in P1	# of novel* viruses found in P1	# of additional known viruses found in P2	# of additional novel* viruses found in P2	Total
Coronavirus	31	69	18	Coronavirus	149
Paramyxovirus	12	74	8	Paramyxovirus	172
Filovirus	0	0	2	Filovirus	3
Influenza virus	8	0	1	Influenza virus	9
Flavivirus	3	5	3	Flavivirus	12
Hantavirus	4	3	1	Hantavirus	8
Rhabdovirus	0	31	0	Rhabdovirus	36

Some findings not yet approved for release; data for other viral families detected during PREDICT-1 but not targeted in PREDICT-2 are not shown.

**Definition of a novel virus: A virus is considered to be new or novel if it has equal or greater genetic variation than the difference between the two closest known virus species within a family/genus and if it represents a distinct (monophyletic) lineage. Our data are strongly suggestive of a new virus, but such classification can only be conferred by the International Committee on Taxonomy of Viruses (ICTV).*

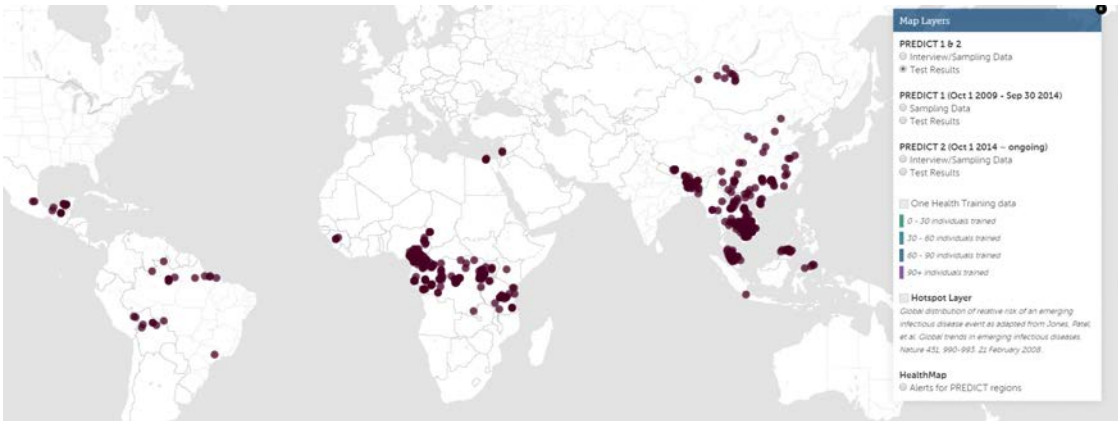
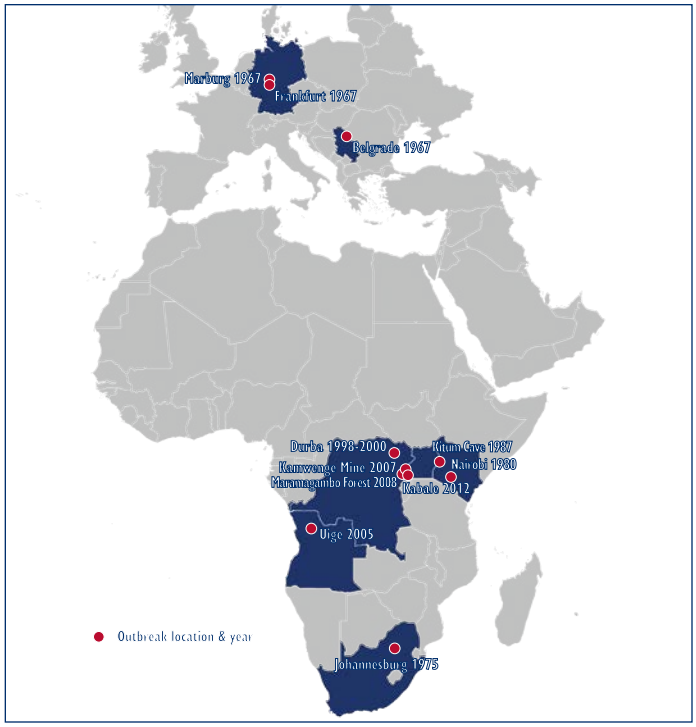


FIGURE 5. Viral map.

A table of comprehensive viral findings approved by host government partners for public release is provided below. All approved viral findings are also available on PREDICT's public site, ***www.data.predict.global****.*

Highlight of viral findings

- **Coronaviruses**: Completed 27 full genome sequences collected from Cambodia, ROC, Rwanda, Malaysia, and Bangladesh to facilitate phylogenetic analyses to better classify the viruses and understand their evolutionary history, as well as to evaluate their zoonotic potential.
- **Evaluated the ability of Bombali virus to antagonize human interferon**: Preliminary evidence suggests that Bombali virus is a poor antagonist of human interferon. This finding suggests that the virus may not induce a severe pathogenic response in people. Additional work is ongoing to fully characterize this response.
- **Generated additional NPC1 sequences for ebolavirus host susceptibility project**: An additional 25 NPC1 sequences were generated from bats and rodents. NPC1 is the host receptor used by filoviruses to enter cells. These sequences are now being used to assess species susceptibility to different ebolaviruses.
- **Detection of Marburg virus in West African rousette bats**: Marburg virus was detected in five Egyptian rousette bats (*Rousettus aegyptiacus*) in Sierra Leone. These infected bats were identified in caves near Moyamba, Koinadugu/Falaba, and Kono districts. Multiple strains of Marburg virus were found, including the Angola strain, a lineage of virus that emerged at a Marburg virus outbreak in 2005 in Angola. This is the first time that the Angola stain has been detected in bats (Figure 5). It also has provided further, productive impetus for collaborations with the CDC Special Pathogens Branch.
- **Detection of Ebola virus (species Zaire ebolavirus) in a greater long-fingered bat (Miniopterus inflatus) in Liberia**: An oral swab tested positive for Ebola virus (EBOV) by real-time PCR and was confirmed positive by sequencing. Approximately 20% of the genome was recovered. Preliminary analysis suggests the virus is the same or a close relative of the West African outbreak strain. Serum collected from this bat neutralized recombinant Vesicular Stomatitis Virus (VSV)-expressing EBOV glycoprotein (Figure 6).



PREVIOUS OUTBREAKS OF MARBURG HEMORRHAGIC FEVER

FIGURE 6. Marburg virus was detected in Egyptian rousette bats (Rousettus aegyptiacus) in Sierra Leone. This is the first time the virus has been found in West Africa and is more than 2,700 km from the closest previously reported detection.

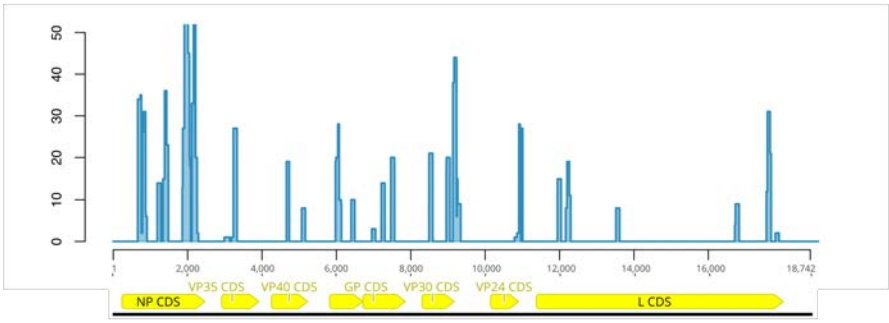


FIGURE 7. Ebola virus (species Zaire ebolavirus) was detected in a greater long-fingered bat (Miniopterus inflatus) in Liberia. Plot shows that approximately 20% of the genome has been sequenced.

Tools in development

- **Paramyxoviruses**: Vesicular Stomatitis Virus (VSV) pseudotype particles have been developed that incorporate different genes from paramyxoviruses, including a PREDICT virus found in bats. The goal is to assess the ability of these genes to medicate entry and replication in human and animal cells.

- **Ebola Serologic Assay**: Optimization of the PREDICT ebolavirus ELISA and western blot assays for testing human sera has been completed with samples from eastern DRC, and the assays are now being used to test a second batch of human samples from Uganda. Bat samples for further testing have now been shipped from Sierra Leone, Guinea, and Liberia to the US.

- **Refining our deep-sequencing approach**: We continued data collection and ongoing analyses to compare results of high throughput sequencing using unbiased sequencing with VircapSeq-VERT and to evaluate factors that affect sequencing.

- **Development of ebolavirus reagents**: Antibodies against proteins of the new Bombali virus have been produced (GP, NP, VP24, VP35). Recombinant VSV expressing the Bombali glycoprotein has also been developed. These reagents are now being used to understand Bombali virus infection in human cells and look for evidence of exposure in human populations.

TABLE 1. Viral findings approved for release by country, taxa, year and season indicating the number of positive individuals for each virus detected

COUNTRY	VIRUS	TAXA	2015 Dry	2015 Wet	2016 Dry	2016 Wet	2017 Dry	2017 Wet	2018 Dry	2018 Wet
Bangladesh	Influenza A	Birds			1		3			
		Poultry/other fowl			10		45			
	Strains of Newcastle Disease Virus	Poultry/other fowl					22			
	Peste des petits ruminants (PPR)	Goats/sheep	2					2		
	Strain of Alphacoronavirus 1	Dogs					2			
	Strain of Avian Paramyxovirus 6	Poultry/other fowl					7			
	Strain of Duck Coronavirus	Poultry/other fowl					37			
	Strain of Infectious bronchitis virus (IBV)	Birds					3			
		Poultry/other fowl					29			
	Strain of Murine coronavirus	Rodents/shrews			1					
	Strain of Pigeon-Dominant Coronavirus	Poultry/other fowl					9			
	PREDICT_CoV-17	Bats								4
	PREDICT_CoV-52	Bats				1		2		
	PREDICT_CoV-56	Bats				5				
	PREDICT_CoV-86	Bats				1				
	PREDICT_CoV-88	Bats				4				
	PREDICT_CoV-89	Bats				1				
	PREDICT_CoV-90	Bats				3				
	PREDICT_PMV-103	Bats				1				
	PREDICT_PMV-104	Bats				1				
	PREDICT_PMV-109	Bats				1				
	PREDICT_PMV-20	Rodents/shrews				5				
Cambodia	Strain of Bat coronavirus 512/2005	Bats	2			26				
	Strain of Infectious bronchitis virus (IBV)	Poultry/other fowl						6		
	Strain of Lonquan Aa mouse coronavirus	Rodents/shrews	37	22	4	7				
	Strain of Murine coronavirus	Rodents/shrews	70	62	29	12				
	Strain of Tembusu virus	Poultry/other fowl						2		
	Thottapalayam virus	Rodents/shrews	2							
	PREDICT_CoV-100	Poultry/other fowl					1	1		
	PREDICT_CoV-102	Poultry/other fowl						3		
	PREDICT_CoV-24	Bats								
	PREDICT_CoV-25	Bats	1							
	PREDICT_CoV-35	Bats				2				
	PREDICT_CoV-56	Bats				1				
	PREDICT_PMV-13	Bats	6			18				
	PREDICT_PMV-63	Bats	1							
	PREDICT_PMV-66	Bats	3			6				
	PREDICT_PMV-67	Bats	9			1				
	PREDICT_RbdV-21	Bats	1							
	PREDICT_RbdV-28	Bats	1							
	PREDICT_RbdV-31	Bats	2							
	PREDICT_RbdV-32	Bats	1							
	PREDICT_RbdV-33	Bats	1							
Cameroon	Human Parainfluenzavirus 2	Humans					1			
	Influenza A	Humans					4	3		
	Monkey pox	Environment sample				7				
		Non-human primates				5				
	Strain of Bat coronavirus Hipposideros	Bats								1
	Strain of Bat-related Human Coronavirus 229E	Bats				16	4	15		3
	Strain of Zaria Bat Coronavirus	Bats					2	8		
	PREDICT_CoV-30	Bats	1							
	PREDICT_CoV-35	Bats	2							
	PREDICT_CoV-44	Bats				1	2	1		3

	PREDICT_CoV-54	Bats				10	3		
	PREDICT_CoV-66	Bats		2					
	PREDICT_CoV-75	carnivores			1				
	PREDICT_CoV-81	Bats			11	3	3	1	
	PREDICT_PMV-101	Rodents/shrews				3	1		
	PREDICT_PMV-127	Bats			2	1			
	PREDICT_PMV-131	Rodents/shrews			1		1		
	PREDICT_PMV-133	Bats			1		1		
	PREDICT_PMV-79	Bats			1				
	PREDICT_PMV-80	Bats			1	1			
	PREDICT_PMV-82	Bats Rodents/shrews							
China	Influenza A	Humans		3					
	Strain of Bat Coronavirus 1	Bats			32				
	Strain of Bat Coronavirus HKU10	Bats			6				
	Strain of Bat coronavirus HKU2	Bats			3		28		
	Strain of Bat coronavirus HKU6	Bats					44		
	Strain of Bat coronavirus HKU8	Bats			3				
	Strain of Bat coronavirus HKU9	Bats					6		
	Strain of Bat paramyxovirus isolate BtHp-ParaV/GD2012	Bats					2		
	Strain of Hipposideros_Bat_ Alphacoronavirus MJ/67C	Bats					2		
	Strain of Rhinolophus/Hipposideros Alpha-coronavirus	Bats			1				
	Strain of SARS-related betacoronavirus Rp3/2004	Bats					14		
	Strain of SARS-related betacoronavirus RsSHC014	Bats			1				
	PREDICT_CoV-22	Bats			11		32		
	PREDICT_CoV-23	Bats					1		
	PREDICT_CoV-79	Bats			8		29		
	PREDICT_CoV-95	Bats					2		
	PREDICT_PMV-123	Bats					1		
	PREDICT_PMV-129	Bats					1		
	PREDICT_PMV-130	Bats					1		
	PREDICT_PMV-134	Bats					1		
	PREDICT_PMV-135	Bats					1		
	PREDICT_PMV-136	Bats					1		
	PREDICT_PMV-47	Bats					3		
	PREDICT_PMV-49	Bats			1		1		
	PREDICT_PMV-88	Bats			1				
	PREDICT_PMV-89	Bats			1				
	PREDICT_PMV-90	Bats			1				
Democratic Republic of the Congo	Zaire Ebolavirus (EBOV) - Équateur province outbreak	Humans							1
	Strain of Bat coronavirus Hipposideros	Bats		1					
	Strain of Eidolon bat corona-virus/Kenya/ KY24/2006	Bats			8				
	Strain of Kenya bat corona-virus/BtKY56/ BtKY55	Bats	1		2	1			
	Strain of Pan paniscus lymphocryptovirus 1	Non-human primates		2	2				
Egypt	Strain of Bat coronavirus HKU9	Bats					6		
	Strain of Rousettus Bat Coronavirus/NRC-1	Bats					4		
	Strain of Rousettus Bat Coronavirus/NRC-2	Bats					8		
	PREDICT_PMV-113	Bats		1					
	PREDICT_PMV-114	Bats					1		
	PREDICT_PMV-115	Bats					1		

Egypt	PREDICT_PMV-116	Bats						1		
	PREDICT_PMV-118	Bats				12				
	PREDICT_PMV-119	Bats				1				
Jordan	Strain of Bat Alphacorona-virus/GS2013/HuB2013	Bats					5			
	Strain of Bat Coronavirus BM48-31/BGR/2008	Bats					28			
	Strain of Bat coronavirus HKU9	Bats					2			
	Strain of Betacoronavirus 1 (OC43)	Bats					1			
	Strain of Bat-related Human Coronavirus 229E	Bats					17			
	PREDICT_CoV-65	Bats					5			
	PREDICT_CoV-91	Bats					1			
Kenya	PREDICT_CoV-90	Bats								5
	Strain of Chaerephon bat corona-virus/Kenya/KY22/2006	Bats								1
Lao PDR	Strain of Lonquan Aa mouse coronavirus	Rodents/shrews				2				
Liberia	Zaire Ebolavirus (EBOV)	Bats					1			
Malaysia	Strain of Infectious bronchitis virus (IBV)	Poultry/other fowl					1			
	Strain of Murine coronavirus	Rodents/shrews		1			1		1	
	Strain of Philippines/Diliman1525G2/2008	Bats						1		
	PREDICT_CoV-52	Bats		1			5			
	PREDICT_CoV-76	Bats		3						
		Rodents/shrews		1						
	PREDICT_CoV-78	Bats	2	7	1		1		4	1
		Rodents/shrews		1			1		1	9
	PREDICT_CoV-80	Bats	3							
	PREDICT_CoV-84	Bats		1			1	1		
	PREDICT_CoV-87	Bats						4		
	PREDICT_Flavi-6	Bats					2			
	PREDICT_PMV-105	Bats		1						
	PREDICT_PMV-106	Bats					2			
	PREDICT_PMV-107	Bats					2			
	PREDICT_PMV-108	Bats					1			
	PREDICT_PMV-110	Bats					1			
	PREDICT_PMV-120	other				1				
	PREDICT_PMV-137	Bats							1	
	PREDICT_PMV-72	Bats		2						
	PREDICT_PMV-74	Bats				1	1			
	PREDICT_PMV-81	Bats		4						
	PREDICT_PMV-98	Bats					1			
	PREDICT_PMV-99	Bats					1			
Mongolia	Influenza A	Birds				31	15			
Myanmar	PREDICT_CoV-35	Bats						1	3	
	PREDICT_CoV-47	Bats					2			
	PREDICT_CoV-82	Bats					3			
	PREDICT_CoV-90	Bats							1	
	PREDICT_CoV-92	Bats						36		
	PREDICT_CoV-93	Bats						3		
	PREDICT_CoV-96	Bats						5		
	PREDICT_PMV-132	Rodents/shrews						2		
	PREDICT_PMV-48	Bats						4		

Nepal	Influenza A	Birds	12					
		Humans				10		
	Strain of Duck Coronavirus	Birds	25					
	Strain of Infectious bronchitis virus (IBV)	Birds	3					
	Strain of Murine coronavirus	Rodents/shrews	4					
	Strain of Newcastle Disease Virus	Birds	8					
	PREDICT_PMV-83	Rodents/shrews	1					
Republic of Congo	Strain of Kenya bat coronavirus/BtKY56/BtKY55	Bats		11				
					2			
	PREDICT_CoV-30	Bats						
Rwanda	Strain of Chaerephon bat coronavirus/Kenya/KY22/2006	Bats		1				
	Strain of Eidolon bat coronavirus/Kenya/KY24/2006	Bats			19	1		
	Strain of bat-related Human Coronavirus 229E	Bats		2				
	Strain of Kenya bat coronavirus BtKY33/2006	Bats		1				
	PREDICT_CoV-44	Bats		7				
	PREDICT_CoV-77	Bats		1				
	PREDICT_CoV-94	Rodents/shrews						2
	PREDICT_PMV-56	Bats			1			
Sierra Leone	Bombali Ebolavirus (BOMV)	Bats				3		
	Marburg virus (MARV)	Bats						2
Tanzania	Strain of Bat coronavirus HKU9	Bats			3			7
	Strains of Betacoronavirus 1 (OC43)	Humans					3	
	Strain of Chaerephon bat coronavirus/Kenya/KY22/2006	Bats						1
	Strain of Eidolon bat coronavirus/Kenya/KY24/2006	Bats			1			4
	PREDICT_CoV-97	Bats			1			
	PREDICT_PMV-141	Bats			1			
	PREDICT_PMV-143	Rodents/shrews						1
	PREDICT_PMV-144	Rodents/shrews			1			1
	PREDICT_PMV-146	Rodents/shrews			1			
	PREDICT_PMV-150	Rodents/shrews			1			
Thailand	Nipah Virus	Bats				2		
	Strain of Bat Coronavirus 1	Bats		1				
	Strain of Murine coronavirus	Rodents/shrews				9	2	
	PREDICT_CoV-17	Bats				13		
	PREDICT_CoV-22	Bats		7				
	PREDICT_CoV-27	Bats		3				
	PREDICT_CoV-47	Bats		5			6	
	PREDICT_CoV-68	Bats				9		
	PREDICT_PMV-2	Bats				4		
	PREDICT_PMV-20	Rodents/shrews					2	
	PREDICT_PMV-85	Bats				1		
	PREDICT_PMV-86	Rodents/shrews				2		
Viet Nam	Influenza A	Swine				26		
	Strain of Porcine Parainfluenzavirus 1	Swine	1			2		

MODELING & ANALYTICS (M&A)

Major highlights & successes

This period, PREDICT's M&A team focused on four major themes:

1) Demonstrating how we can analyze PREDICT data to increase the efficiency of surveillance programs and predictive power of our models.
2) Intervention Modeling Projects ACross Teams (IMPACT) that help test proposed broad-based intervention strategies that derive from PREDICT results.
3) Working with EPT partners to produce maps, models, and other products that help them design their programs, test hypotheses, and hone their One Health strategic plans.
4) Designing new analytical strategies and open-source tools to analyze risk of disease emergence.

1) Analyzing PREDICT data to increase efficiency of surveillance programs

Analyses were conducted to examine whether surveillance can be targeted seasonally to a period when the risk of disease emergence is greatest. We used longitudinal serological data from Bangladesh to identify co-circulation dynamics of Nipah, filovirus, and Rubulavirus in a bat population of the species Pteropus medius. We show that each virus has different periods/months when seroprevelance is significantly increasing or decreasing, and the calculated risk of viral shedding is greatest. We also analyzed these data to show that individual bats can be co-infected with multiple viruses (see Figure 1).

Therefore, interventions to mitigate the spillover of viruses from this one fruit bat species will need to consider different periods of viral shedding, and a single intervention to mitigate human exposure may have the benefit of reducing spillover risk for multiple viruses.

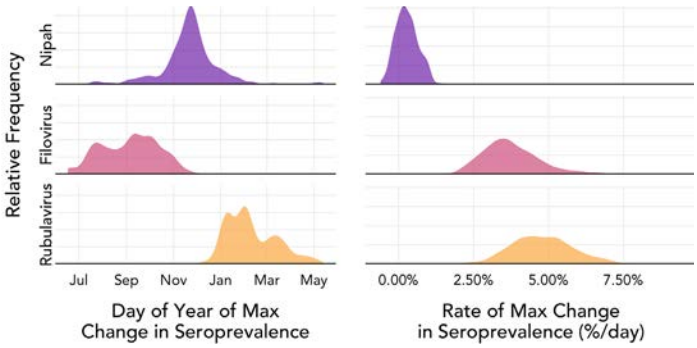


FIGURE 1. Analysis of serological data for three viruses to determine the timing and strength of viral circulation in juvenile bats from a longitudinal dataset from Bangladesh. Plots show periods of the year when the increase in seroprevalence is greatest (left), and the rate of change for each virus (right). Plots display the relative frequency from 1,000 generalized additive model runs.

PREDICT is analyzing the specific risk of viral emergence across the wildlife market value chain. Using data from bushmeat market surveys in North Sulawesi, Indonesia (see Figure 2), models are being developed to quantify the areas of greatest risk for bat- and rodent-borne zoonotic virus emergence. We identified markets that sell fresh and frozen bats, rats, wild pigs, and snakes. Daily observational data are being used to calculate the volume of wildlife sold monthly/annually and will feed in to IMPACT projects (Intervention Modeling Projects ACross Teams) to assess the specific risk that these markets play in disease spillover and spread.

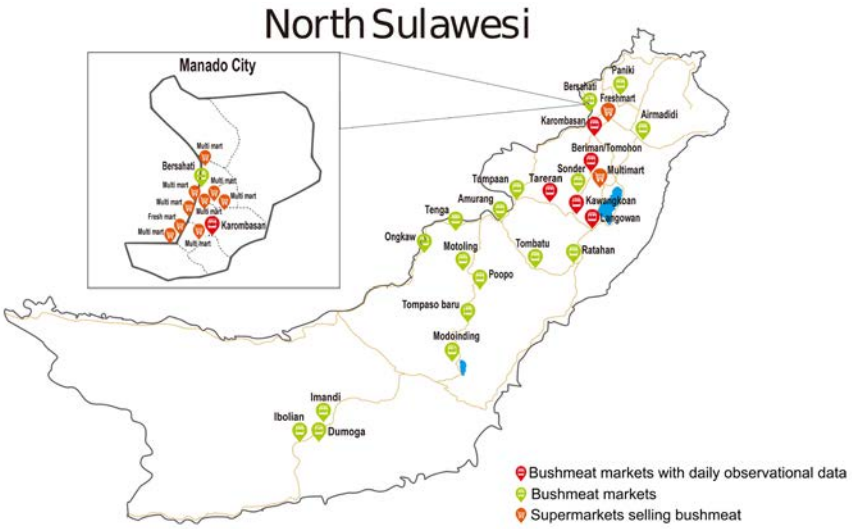


FIGURE 2. Map of the wildlife trade/value chain in North Sulawesi, Indonesia. Green markers indicate bushmeat markets surveyed by PREDICT, and red denotes markets where daily observational data were recently collected. Supermarkets where bushmeat is also available are marked in orange.

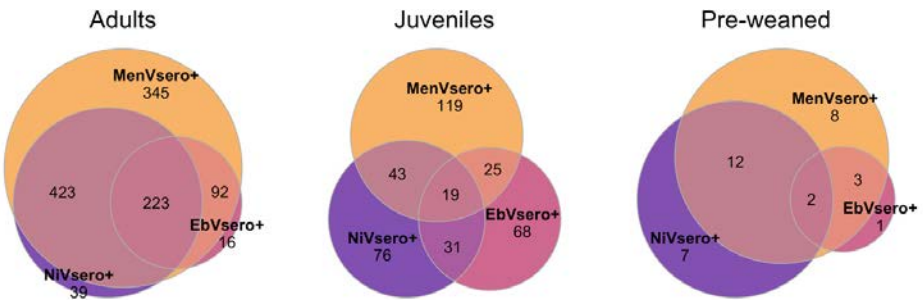


FIGURE 3. Patterns of seropositivity to multiple viruses in fruit bats from Bangladesh. Venn diagrams for adult, juvenile, and pre-weaned (dependent) Pteropus medius bats testing positive for antibodies against Nipah virus, filovirus, and rubulavirus. Numbers under labels are counts of bats with only seroreactivity to those viruses. Numbers in overlapping areas represent number of bats detected with multiple viruses or evidence of co-immunity.

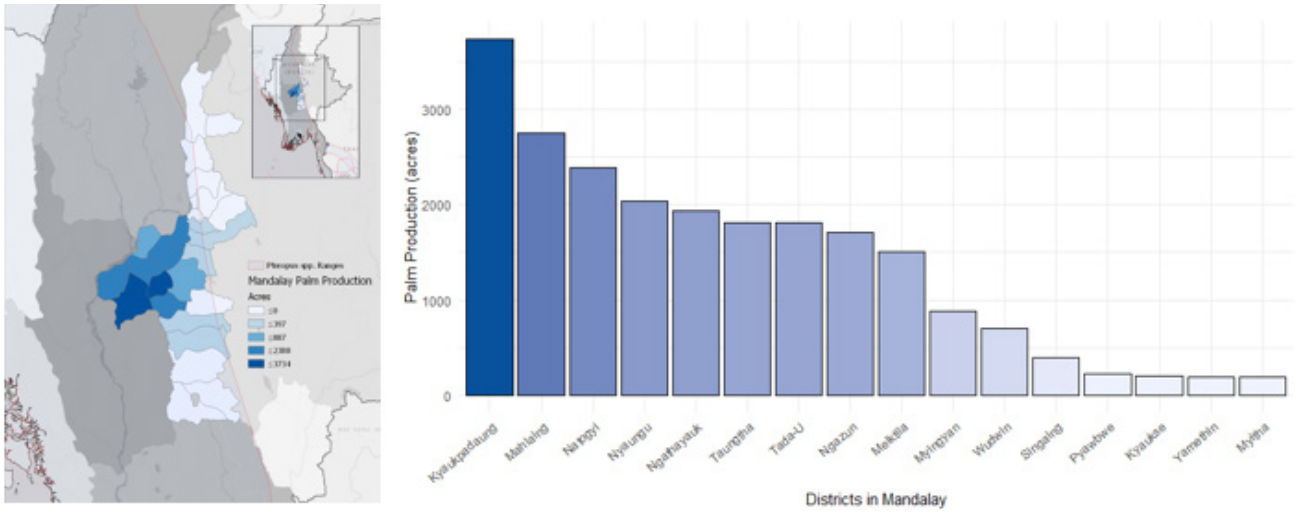


FIGURE 4. Date palm sap harvesting data from Myanmar by district in Mandalay being used to map the risk of bat-borne virus spillover risk.

2) Analyses to test proposed broad-based intervention strategies

The PREDICT M&A, Surveillance, and Behavioral Risk teams continue to develop analyses to assess potential evidence-based risk interventions and define the boundaries within which interventions might prove successful. Over the last six months, significant progress has been made on 15 IMPACT projects focused on different risk factors or specific interfaces of disease emergence. Over the remaining six months of the project, the M&A team will continue to coordinate across PREDICT, USAID EPT, and our in-country teams in modeling, capacity-building, and scientific communication efforts. Outputs from all analyses will be developed as short, policy-relevant Emerging Disease Insight documents for distribution to key stakeholders and the public.

3) Working with EPT partners to produce maps, models and other products of value for their programs

PREDICT continued to collaborate with FAO on the Africa Sustainable Livestock 2050 (ASL2050) project to model the risk of disease in the face of expanding livestock production in Africa (see Figure 5). We produced geospatial maps of cattle density under three future scenarios of agricultural development: 1) Stratified societies, 2) Business as usual, and 3) Toward sustainability. Countries included in these forecasts: Burkina Faso, Uganda, Kenya, Nigeria, Egypt, and Ethiopia.

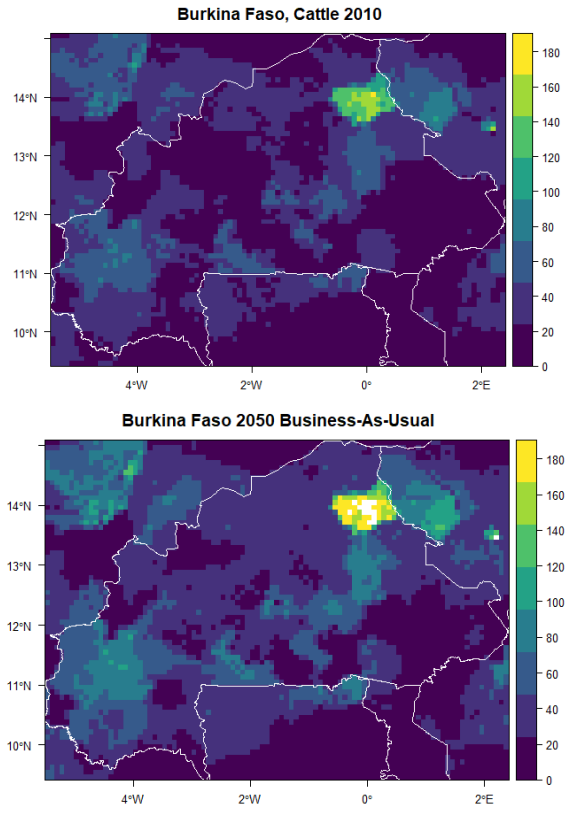
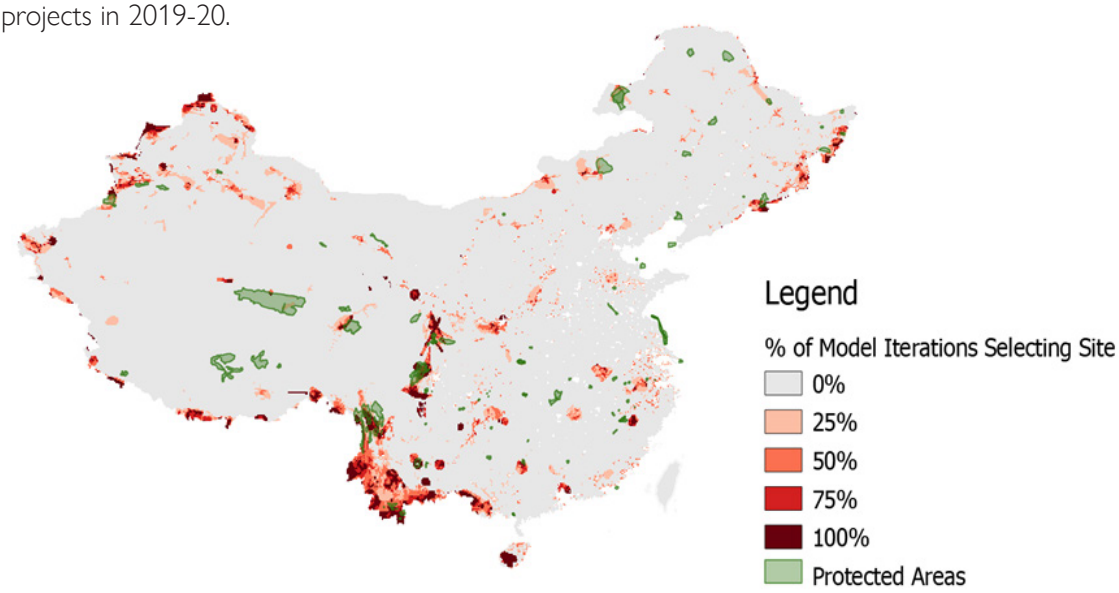


FIGURE 5. Forecasted changes in cattle density for Burkina Faso from 2010 to 2050 under a business-as-usual scenario. Maps produced by PREDICT as part of the Africa Sustainable Livestock 2050 (ASL2050) project in collaboration with FAO.

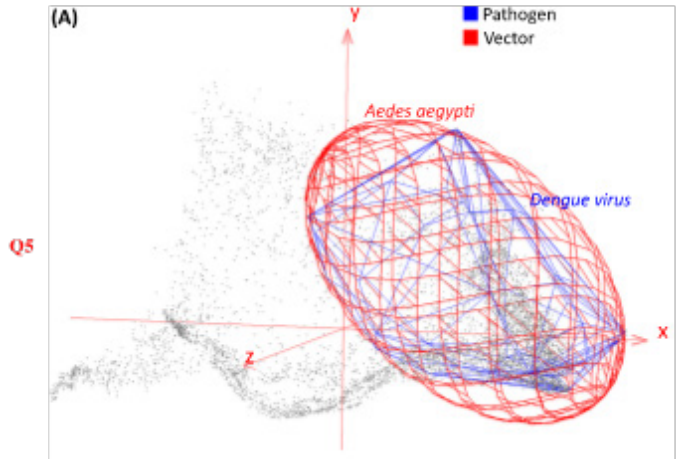
PREDICT's M&A team supported the development and strategic design of the Global Virome Project (GVP). We designed a spatial modeling approach to identify priority sites for targeted wildlife sampling at a 10 x 10 km resolution in countries of relevance to the GVP. PREDICT developed specific maps for the Thai National Virome Project (TNVP) and the China Virome Project and presented these at the TNVP launch, as well as in high-level meetings with Chinese Government and US Embassy leaders in Beijing. These analyses will form the basis for the design of specific workplans in both countries during the rollout of their virome projects in 2019-20.



Optimizing sites for the China Virome Project, part of the GVP. Darker shaded areas on the map (red and dark red) are sites that were consistently identified by the model as the optimal areas to discover the greatest number of viruses using the fewest resources. Protected areas in China shown in green.

4) New analytical strategies and open-source tools to analyze risk of disease emergence

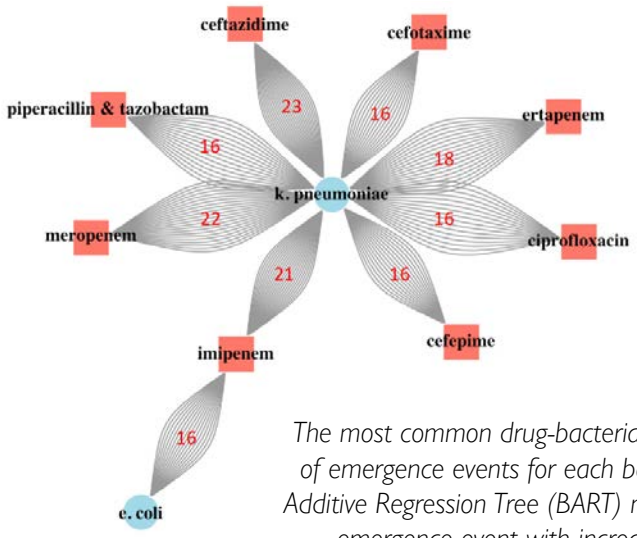
We continued developing new tools within the EIDITH R package to facilitate the cleaning and analysis of project data. These open-source tools allow country and global teams to download their country-level PREDICT-2 data, clean datasets by automatically identifying outliers and fields with missing or incorrect data, and analyze patterns in the data using the statistical analysis program, R. Site characteristics, behavioral risk, animal, or testing data can then be manipulated in R to explore and visualize data from the project in near real-time, as it's entered into the database.

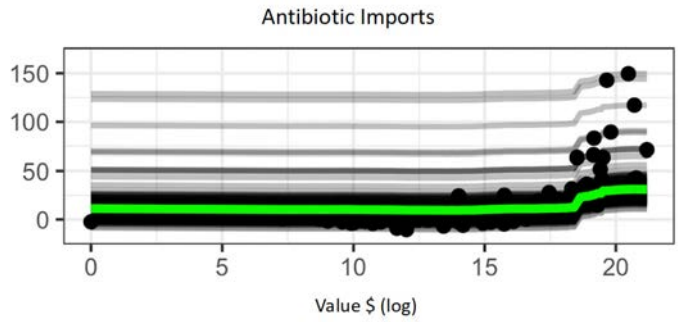


PREDICT developed a new theoretical model of disease distribution using ecological niche models. Example bottom-left shows how dengue virus (blue polyhedron) distribution coincides with that of its vector, the mosquito Aedes aegypti (red ellipsoid).

PREDICT developed a new theoretical framework for modeling the geography of disease transmission using biological properties of both hosts and parasites to produce reliable outputs of disease distributions. These analyses can be used to better map and help guide the surveillance and discovery of pathogens across the landscape.

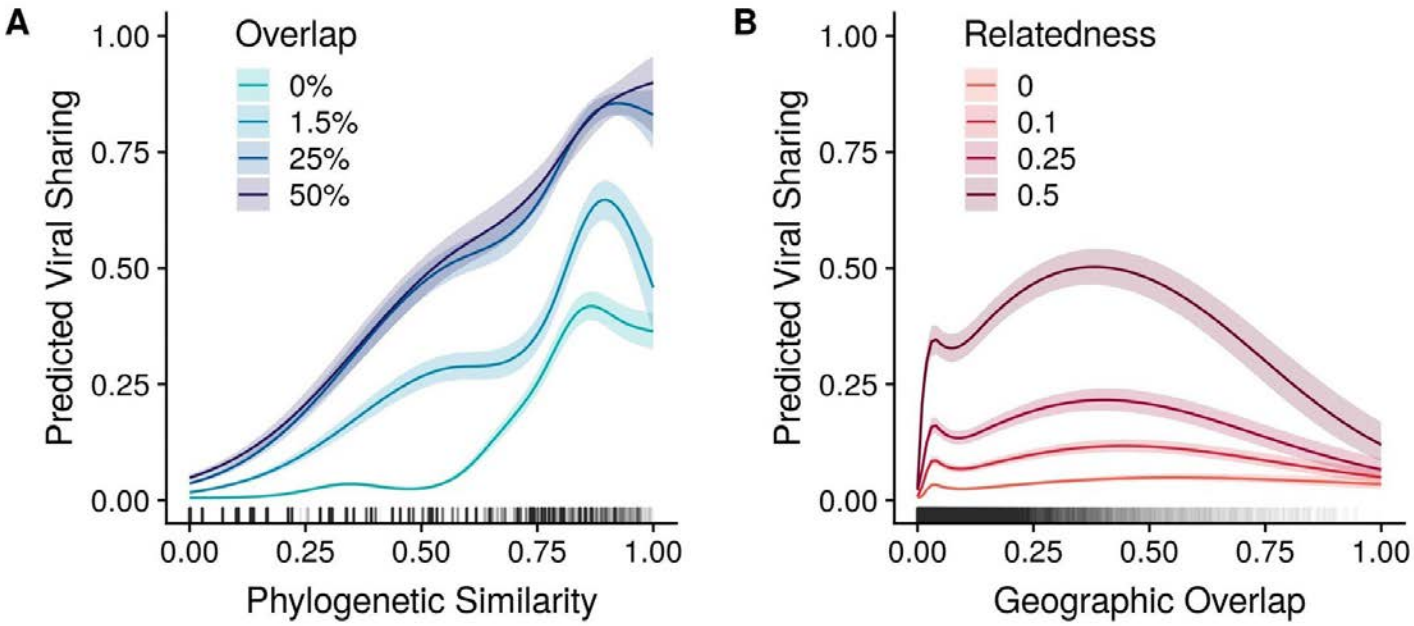
PREDICT completed the most comprehensive database to date to analyze the drivers of antimicrobial resistance (AMR) disease emergence in people. This effort involved data extraction and data cleaning from over 24,000 scientific papers published from 2006-2017. PREDICT is currently using this database to develop an AMR "hotspots" map to show areas around the world where future AMR emergence is most likely. Preliminary analysis using Bayesian Additive Regression Tree (BART) models are underway to identify potential risk factors that explain the number of AMR events within a country. Variables include: research bias, percentage of agricultural land cover, livestock index, GDP, and % of GDP spent on healthcare, population, antibiotic imports, and antibiotic exports.





The most common drug-bacteria combinations in PREDICT's AMR database are displayed. The number of emergence events for each bacteria-drug combination are shown in red (left). Example of Bayesian Additive Regression Tree (BART) model output showing an increase in the per-country risk of a new AMR emergence event with increasing levels of antimicrobial drug imports for a given country (right).

Building off previously published PREDICT analyses to identify host and viral traits that predict zoonotic potential, we developed new models to explain viral sharing between all mammal species. Specifically, phylogenetic similarity and geographic overlap were used to predict a viral sharing network across all known mammals (~5000 species). These analyses found that more closely related species and those that overlap the most in space, are much more likely to share viruses. The relationship of these factors was non-linear, and the two variables interact so that phylogenetic similarity has a stronger effect on species that overlap more, and conversely overlap matters more when species are more closely related.



New PREDICT model to examine factors that determine viral sharing among all known mammal species. These plots show the interacting, non-linear effect of host species relatedness (left) and geographic overlap (right).

For more information

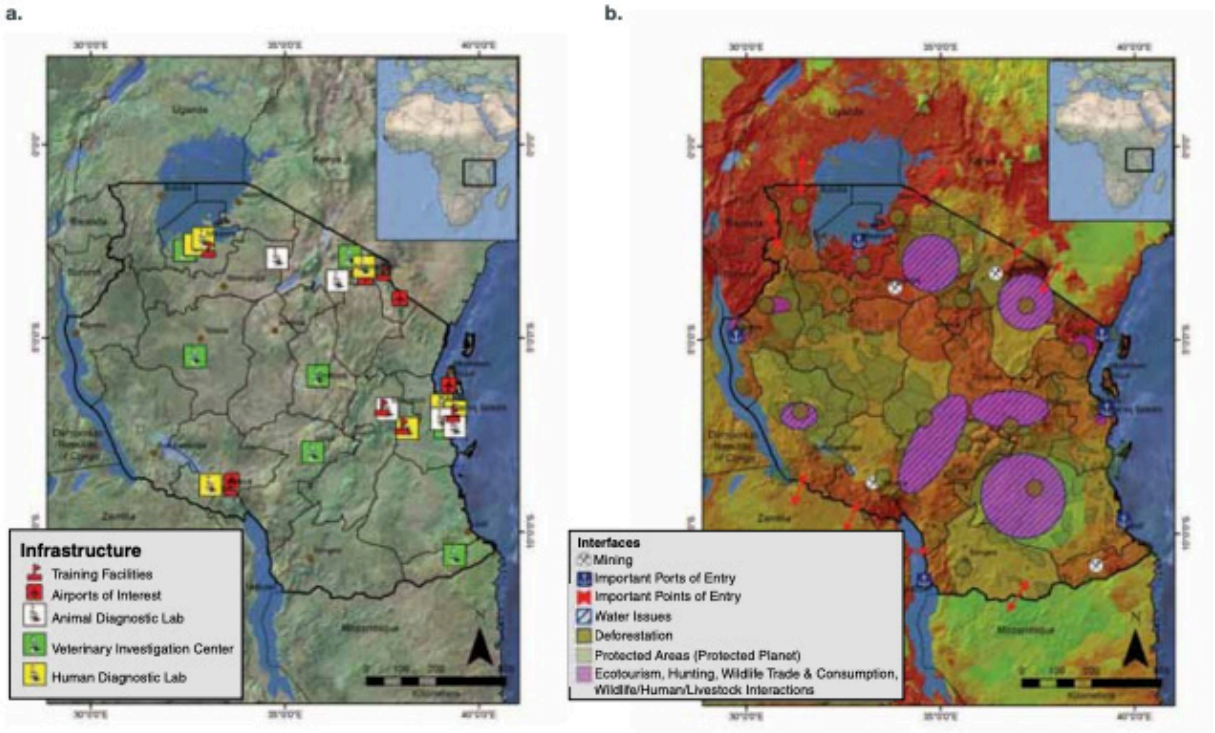
Emerging Disease Insights are available online: **livescience.ecohealthalliance.org**

One Health policy advocacy

To set the path for success under the second phase of the Global Health Security Agenda (GHSA), PREDICT-2 had a direct role in shaping the GHSA Roadmap 2024, which sets out annual implementation and outcome objectives, enhancing attention to multisectoral coordination and inclusion of the environment sector. As part of our engagement, PREDICT led the delegation representing non-governmental stakeholders (the Global Health Security Agenda Consortium) at the GHSA Steering Group meeting at the Hague in February 2019. PREDICT has also been appointed as a focal point for the PREVENT 2 – Zoonotic Disease Action Package working group under the Steering Committee. PREDICT helped to develop the work plan for the GHSA Advocacy and Communications Task Force that will oversee compilation of information toward awareness of the GHSA 2024 outcomes, action plan, and implementation, and will show the value of continued prioritization of health security.

Following publication of the World Bank's Operational Framework for Strengthening Human, Animal and Environmental Public Health Systems at their Interface ("One Health Operational Framework") in 2018, to which PREDICT contributed significant technical expertise, we had a key role in circulation of the Framework's key messages and practical guidance to donors, intergovernmental agencies, and countries through a wide variety of fora, providing opportunities to reach additional stakeholders.

Examples include the United Nations Rio Conventions Pavilion event, "Harnessing biodiversity for a healthy and resilient future," convened by the UN Convention on Biological Diversity (CBD) and World Health Organization (WHO) at the CBD 14th Conference of the Parties (COP), the 2nd Wildlife Forum on "Sustainable Use for Conservation and Livelihoods" hosted by the Collaborative Partnership on Wildlife Management, "One Health in the 21st Century" hosted at the Woodrow Wilson Center, a high-level roundtable on "Leveraging global polio eradication assets to support global health security and sustainable universal health coverage" convened by Chatham House with Rotary International, InterAction Council, other partners (non-PREDICT), and the Gates Global Grand Challenges meeting.



Inter-sectoral drivers and capabilities mapping approach (illustrative example; produced by USAID Emerging Pandemic Threats PREDICT in 2012-14). (a) Distribution of human and animal diagnostic resources. (b) Relative risk of an emerging infectious disease from wildlife, based on mammalian diversity and human population density, from bright green (lowest risk) to red (highest risk). Risk interfaces are marked. Airports or border crossings in both indicate possible pathways for international spread of diseases. Source: World Bank One Health Operational Framework for Strengthening Human, Animal, and Environmental Public Health Systems at their Interface 2018.

PREDICT continued collaboration with a range of entities to improve animal and environmental dimensions of health security. Through the International Panel of Experts for the Global Health Security Index under development by the Nuclear Threat Initiative, the Economist Intelligence Unit, and the Johns Hopkins School of Public Health we helped to integrate One Health-relevant indicators on prevention and detection of epidemic and pandemic threats, including zoonoses and antimicrobial resistance. We also participated in the OIE ad hoc group on MERS-CoV, presenting PREDICT findings in the review of criteria for OIE disease listing.

At country level, PREDICT conducted training in Liberia on One Health policy and evaluation, leading to a draft intervention ultimately presented at the plenary at the UN CBD COP14. This intervention helped inform the decision on Health and Biodiversity accepted by Parties, which includes a recommendation for governments and other stakeholders to "review, adjust and improve biodiversity-health linkages in the environmental assessment of relevant projects."

Other highlights & success stories

PREDICT collaborated on the forthcoming WHO Guide for Multisectoral Partnership Coordination for Preparedness, IHR (2005), and Health Security, providing examples from PREDICT and moderating a panel on "Public Health Institutions and Non-State Actors' Engagement for IHR (2005) and health security" at an expert roundtable convened by WHO to collect examples of country-level coordination. This document complements the FAO/OIE/WHO Tripartite Zoonoses Guide on "Taking One Health Approaches to Address Zoonotic Diseases in Countries" published in March 2019, which features approaches shared by PREDICT and refers to several policy and evaluation guidance resources produced by PREDICT.

PREDICT continued to engage technical institutions to promote simplified procedures to promote timely movement of emergency diagnostic specimens, including to address regulations that inadvertently delay investigation of wildlife disease emergencies. Recommendations from the working group convened by countries under the Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES), which PREDICT served on, will advance for final vote at the Conference of the Parties in May 2019. Our team also participated in the development of OIE Guidance on Transport of Biological Specimens.

New publications, products and policy briefs

Key outputs highlighted practical pathways and benefits of multisectoral approaches to global health security and included:

- "Institutionalizing One Health: from Assessment to Action" in Health Security, which PREDICT led in collaboration with partners from the World Bank, WHO, CDC, FAO, OIE, Toward a Safer World Network, and the EPT OHW and P&R projects to show opportunities for alignment of assessment and planning tools.
- "Infectious disease and economics: The case for considering multisectoral impacts" in One Health, on the economic imperative for a wide range of private sector stakeholders to mitigate risks and impacts of emerging infectious diseases.

Selected presentations on PREDICT, One Health, zoonotic diseases and global health security

- Chaired the OIE Working Group on Wildlife Meeting, highlighting new and emerging wildlife disease events and reinforcing the importance of country reporting for wildlife diseases to OIE delegates.
- Presented to a subcommittee of the National Science and Technology Council on the outcomes of a Pandemic Prediction and Forecasting Science and Technology working group workshop on behavioral risk modeling for pandemics.
- Presented on "Digital Disease Detection for Health Security" at the 2018 American Public Health Association meeting, showing tools from PREDICT and its partners that can be used by public health agencies to help monitor and detect disease threats.
- Presented on risk reduction strategies for emerging infectious disease risks linked to ecosystem degradation on a webinar on migration hosted by the World Federation of Public Health Associations working group on health in emergencies and disasters.
- Highlighted PREDICT's work at an expert Symposium on Biosecurity and Transnational Environmental Crime hosted by the Canadian Institute for Advanced Research. Attendees were representatives of law enforcement and intergovernmental agencies.

COUNTRY PROFILES

One Health in action around the world

Photo: Interface in Nepal (credit: Pranav Pandit)

IMPACT

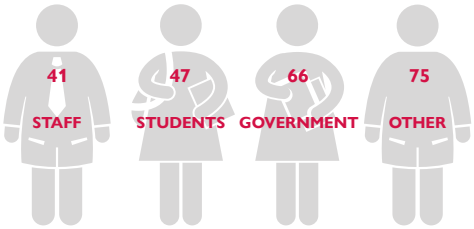
224 trained in One Health skills

4,856 individuals sampled (animals & humans)

941 individuals interviewed

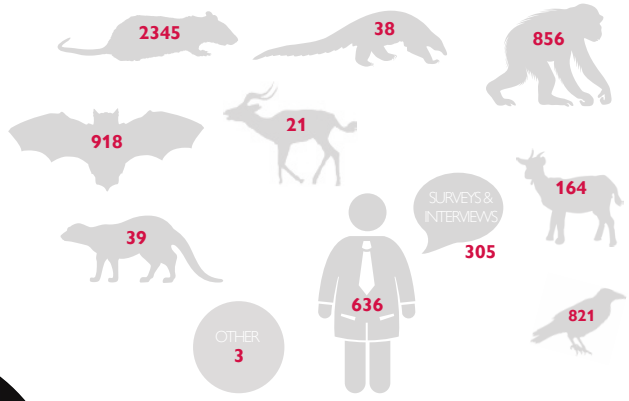
35 unique viruses detected

WORKFORCE DEVELOPMENT



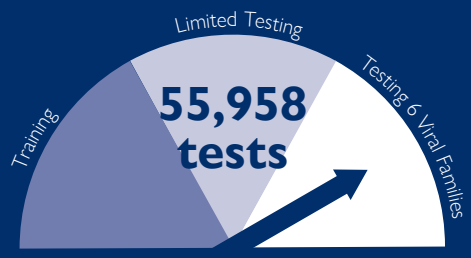
139 MALE | 85 FEMALE

ONE HEALTH SURVEILLANCE



LAB STRENGTHENING

· Military Health Research Center



VIRAL FINDINGS

P1	P2
217 new viruses	**11** new viruses
20 known viruses	**8** PREDICT-1 viruses
	18 known viruses

Global Health Security Agenda

CAMEROON

MOHAMED MOCTAR MOUICHE MOULIOM, DVM, MPH

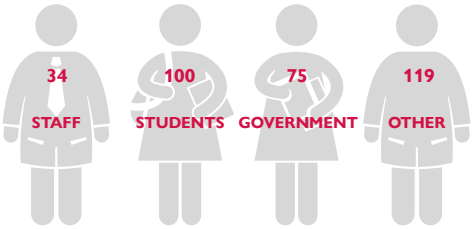
Country Coordinator, PREDICT/Cameroon

PARTNERS

- Metabiota, Inc.
- Global Viral
- Mosaic
- Military Health Research Center (CRESAR)

"PREDICT has effectively contributed to Cameroon's increased capacities for zoonotic disease surveillance and the detection of priority zoonotic diseases and unknown threats. The opportunity to work with specialists from various professional backgrounds and to share their experience has helped me to build my own capacity more efficiently than ever before in the One Health approach and project management. "

WORKFORCE DEVELOPMENT



154 MALE | 53 FEMALE

ONE HEALTH SURVEILLANCE

IMPACT

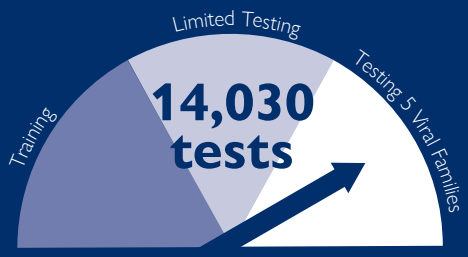
207 trained in One Health skills

1,190 individuals sampled (animals & humans)

635 individuals interviewed

LAB STRENGTHENING

- Institut Pasteur du Côte d'Ivoire
- Laboratoire National d'Appui au Développement Agricole



Global Health Security Agenda

CÔTE D'IVOIRE

EUGENE KOFFI KOUASSI, DVM, MSc

PREDICT/Côte d'Ivoire, Research Associate

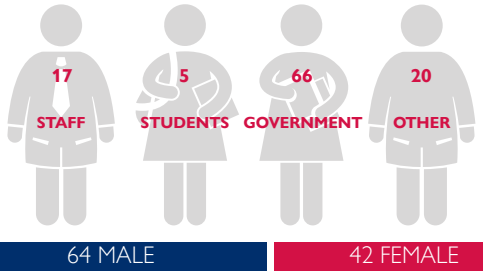
Institut Pasteur Côte d'Ivoire

PARTNERS

- EcoHealth Alliance
- Institut Pasteur de Côte d'Ivoire
- Laboratoire National d'Appui au Développement Agricole

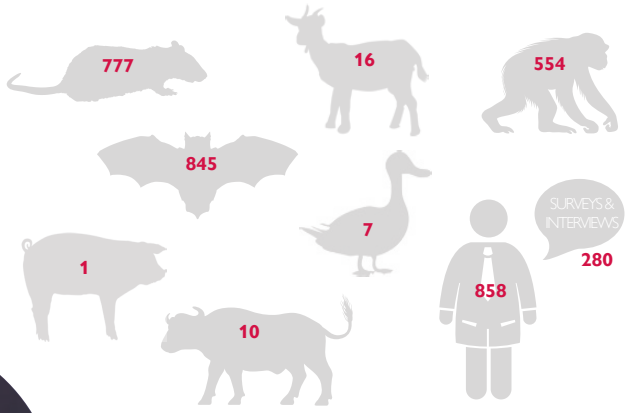
"I have acquired the capacity to develop collaborations with several ministerial sectors: water and forest, animal and human health, administrative authorities, and village authorities in the surveillance of emerging diseases."

WORKFORCE DEVELOPMENT



64 MALE | 42 FEMALE

ONE HEALTH SURVEILLANCE



IMPACT

106 trained in One Health skills

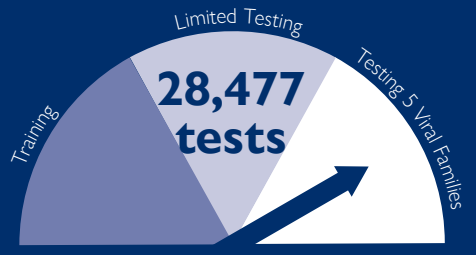
3,068 individuals sampled (animals & humans)

1,138 individuals interviewed

8 unique viruses detected

LAB STRENGTHENING

· Institut National de Recherche Biomédicale



VIRAL FINDINGS

P1	P2
49 new viruses	**1** PREDICT-1 viruses
22 known viruses	**7** known viruses

DEMOCRATIC REPUBLIC OF THE CONGO

Global Health Security Agenda

PLACIDE MBALA, MPH, PhD

PREDICT/DRC, Former Laboratory Manager, INRB
Current Director of Viral Hemorrhagic Fevers Diagnostics Units, INRB

Institut National de Recherche Biomedicale

PARTNERS

- Metabiota, Inc.
- Institut National de Recherche Biomédicale
- Kinshasha School of Public Health
- Mountain Gorilla Veterinary Project
- University of California, Davis

Dr. Mbala now directs the Viral Hemorrhagic Fevers Diagnosis Unit at INRB, and is a key player in the training of physicians, biologists, and laboratory technicians, as well as in the establishment of field laboratories integral to Ebola outbreak response in his country. PREDICT provided Dr. Mbala the opportunity to gain and refine his skills in laboratory management, molecular biology techniques, and field investigations, and through his tireless work and ongoing contributions, Dr. Mbala and those he mentors, improve the capacity of DRC to respond to outbreaks with a One Health approach, and bring a greater understanding of zoonotic diseases in this high-risk area of the world.

IMPACT

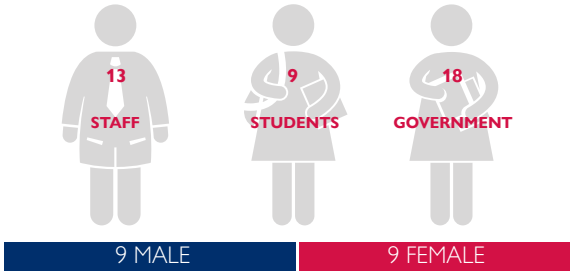
18 trained in One Health skills

2,100 individuals sampled (animals & humans)

1,097 individuals interviewed

9 unique viruses detected

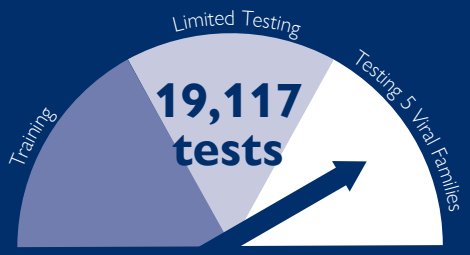
WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE

LAB STRENGTHENING

- Center of Scientific Excellence for Influenza Viruses



VIRAL FINDINGS

P2

6 PREDICT-1 viruses

3 known viruses

EGYPT

PREDICT/EGYPT TEAM

PREDICT-2 Interdisciplinary Teamwork

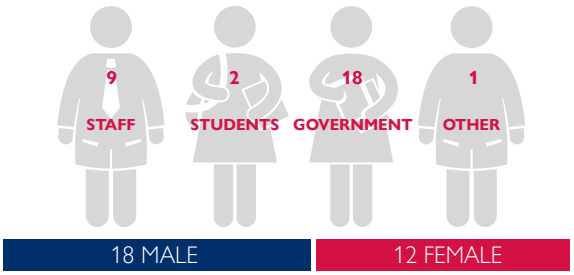
Egypt National Research Centre's Center of Scientific Excellence for Influenza Viruses

PARTNERS

- EcoHealth Alliance
- Egypt National Research Centre

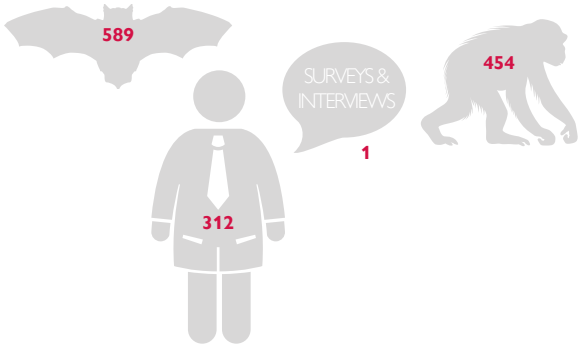
The Egypt team demonstrated how interdisciplinary backgrounds can work together toward a common goal: promoting One Health activities to better understand and respond to viral zoonotic threats in Egypt.

WORKFORCE DEVELOPMENT



18 MALE | 12 FEMALE

ONE HEALTH SURVEILLANCE



IMPACT

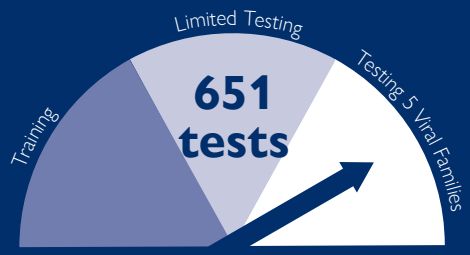
30 trained in One Health skills

1,355 individuals sampled (animals & humans)

313 individuals interviewed

LAB STRENGTHENING

- Addis Ababa University Aklilu Lemma Institute of Pathobiology



ETHIOPIA

Global Health Security Agenda

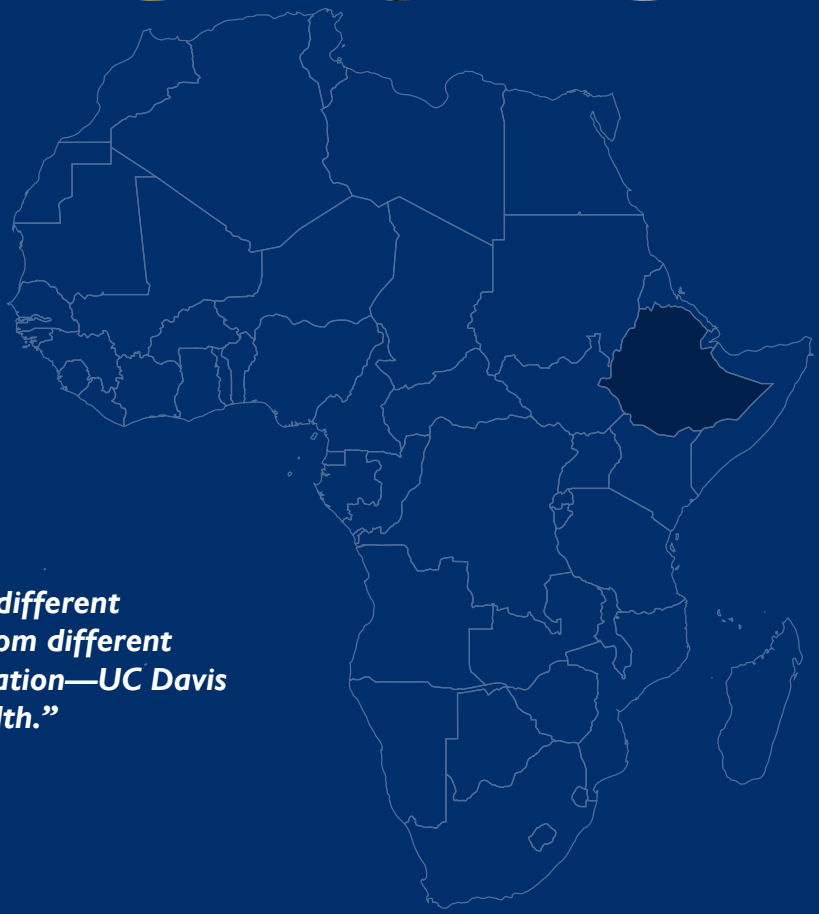
DESALEGN BELAY TAKELE

PREDICT/Ethiopia, Associate Researcher

National Influenza Laboratory, Ethiopian Public Health Institute

PARTNERS

- University of California, Davis
- Addis Ababa University
- Aklilu Lemma Institute of Pathobiology
- Ethiopian Public Health Institute



"It is a special experience to work on different viral families, with other colleagues from different disciplines, and international collaboration—UC Davis is a practical powerhouse of One Health."

Global Health Security Agenda

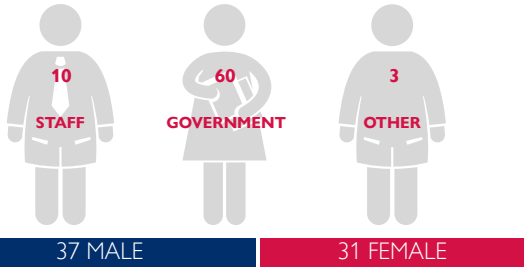
IMPACT

68 trained in One Health skills

3,491 individuals sampled (animals & humans)

641 individuals interviewed

WORKFORCE DEVELOPMENT

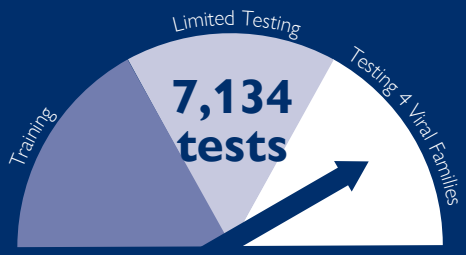


37 MALE | 31 FEMALE

ONE HEALTH SURVEILLANCE

LAB STRENGTHENING

- Accra Veterinary Laboratory
- Noguchi Memorial Institute for Medical Research



GHANA

RICHARD SUU-IRE, DVM, PhD

PREDICT/Ghana, Wildlife Disease Surveillance Lead

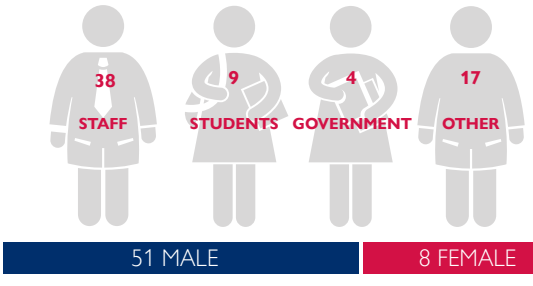
Wildlife Division of the Forestry Commission, Ministry of Land and Natural Resources

PARTNERS

- University of California, Davis
- Wildlife Division of the Forestry Commission, Ministry of Land & Natural Resources
- Veterinary Services Directorate, Ministry of Food & Agriculture
- Noguchi Memorial Institute for Medical Research, University of Ghana
- Ghana Health Services
- Military Hospital of the Ghana Armed Forces

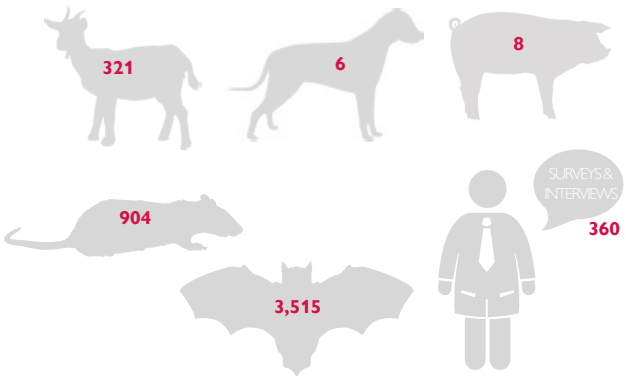
"I look back at my life back to the village where I had to herd cattle and make time for schooling in the face of serious want and feel that I must share the little I have with those who do not have at all."

WORKFORCE DEVELOPMENT



51 MALE | 8 FEMALE

ONE HEALTH SURVEILLANCE



IMPACT

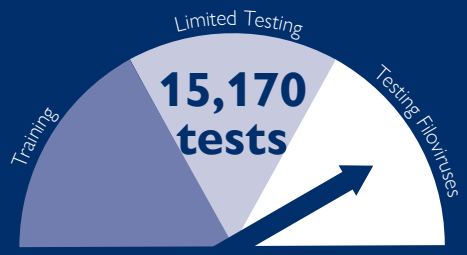
59 trained in One Health skills

4,754 individuals sampled (animals & humans)

360 individuals interviewed

LAB STRENGTHENING

- Laboratoire de Fievres Hemorrhagiques
- UC Davis One Health Institute*



*As part of the Ebola Host Project, samples are being tested at UC Davis to accelerate release of viral findings for use for decision-making and risk-mitigation efforts.

Global Health Security Agenda

GUINEA

POKPA SAKOUVOGUI

PREDICT/Guinea, Student & Community Liaison

SAYON YOMBOUNO

PREDICT/Guinea, Veterinarian

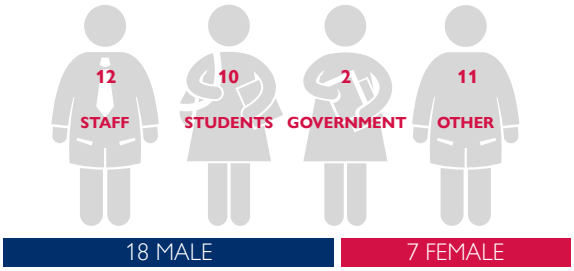
PARTNERS

- University of California, Davis
- Laboratoire de Fievres Hemorrhagiques

"Experiences that I acquired with PREDICT helped me become more professional in my work in general. Also, taking part of research projects that aims to improve the health situation in my country made me proud. This is why I plan to go back to university once the project ends. PREDICT inspired me to become an epidemiologist!"

"This year, when you came to visit my class, you had a book full of pictures with bats and you gave us advice on how to interact with them. I realized that it was not good to play or even touch bats. Since then, I tried to explain to my parents that bats are important for the environment but they could carry dangerous diseases."

WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE

IMPACT

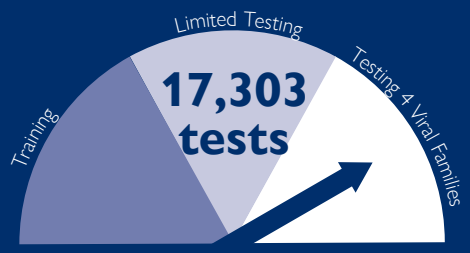
25 trained in One Health skills

2,164 individuals sampled (animals & humans)

1,085 individuals interviewed

LAB STRENGTHENING

· Jordan University of Science and Technology



VIRAL FINDINGS

P2

1 new virus
1 PREDICT-1 viruses
5 known viruses

Global Health Security Agenda

JORDAN

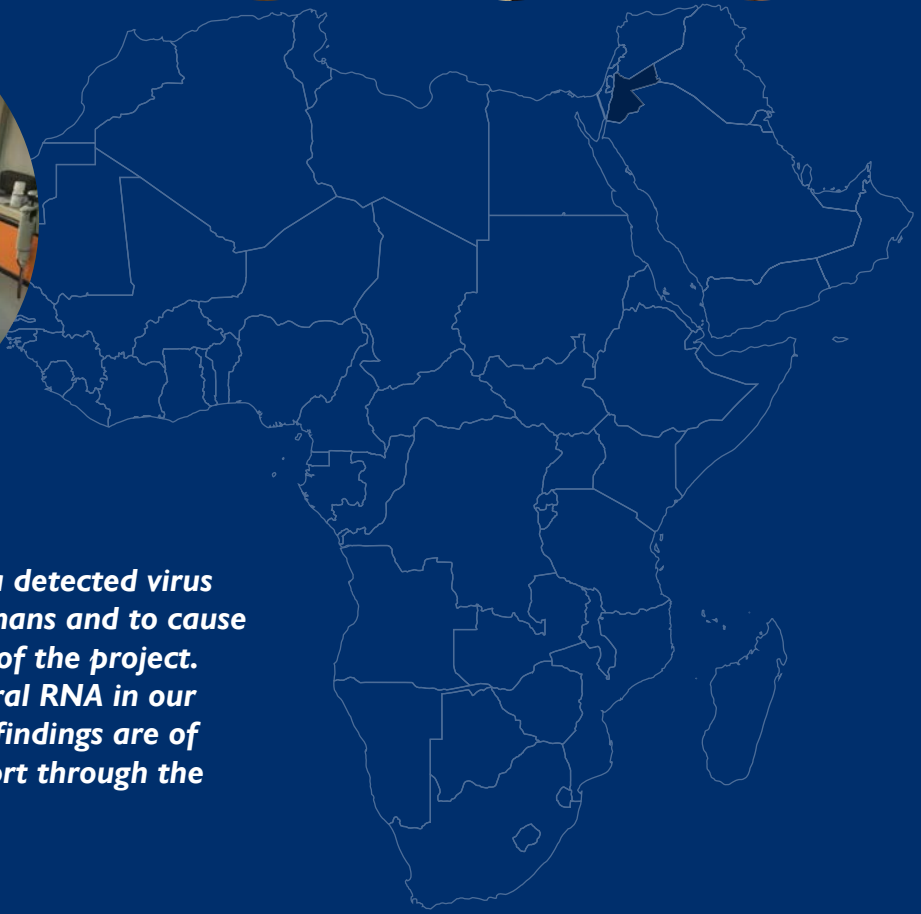
MUSTAFA ABABNEH

PREDICT/Jordan, Technical Laboratory Lead

Jordan University of Science and Technology

PARTNERS

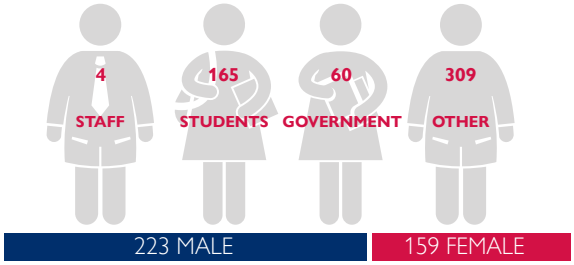
- EcoHealth Alliance
- Jordan University of Science and Technology



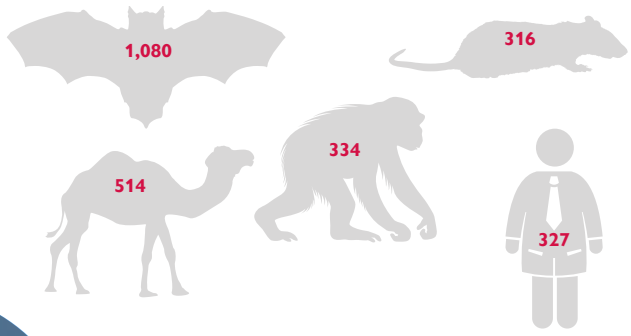
"We are discovering whether a detected virus has the potential to infect humans and to cause illness, which is a central part of the project. We may find a multitude of viral RNA in our samples, so prioritizing which findings are of greater importance helps us sort through the data."

Global Health Security Agenda

WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE



IMPACT

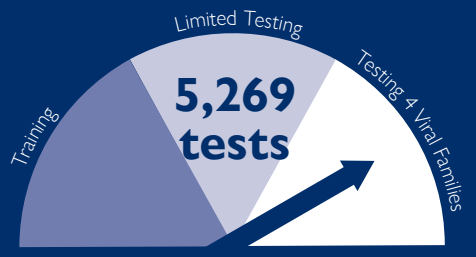
382 trained in One Health skills

1,861 individuals sampled (animals & humans)

327 individuals interviewed

LAB STRENGTHENING

- Kenya Medical Research Institute
- Institute of Primate Research



VIRAL FINDINGS

P2

1 new virus

1 known viruses

KENYA

AMOS RIMFA

PREDICT/Kenya, MS Candidate

Institute of Primate Research

University of Nairobi

PERIS AUMA AMBALA

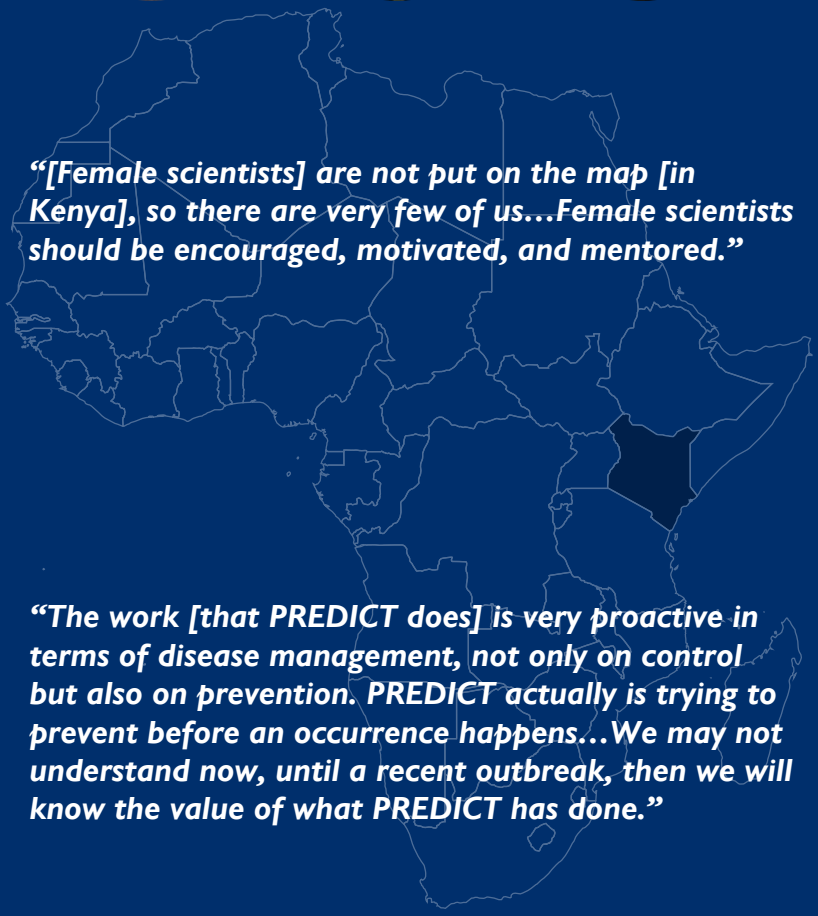
PREDICT/Kenya, PhD Candidate

Institute of Primate Research

Kenyatta University

PARTNERS

- Smithsonian Institution
- Institute of Primate Research
- Kenya Medical Research Institute



"[Female scientists] are not put on the map [in Kenya], so there are very few of us…Female scientists should be encouraged, motivated, and mentored."

"The work [that PREDICT does] is very proactive in terms of disease management, not only on control but also on prevention. PREDICT actually is trying to prevent before an occurrence happens…We may not understand now, until a recent outbreak, then we will know the value of what PREDICT has done."

IMPACT

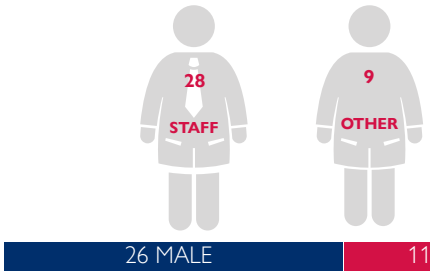
37 trained in One Health skills

5,386 individuals sampled (animals & humans)

95 individuals interviewed

27 unique viruses detected

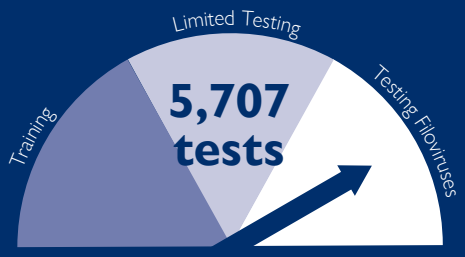
WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE

LAB STRENGTHENING

- National Public Health Institute of Liberia
- Columbia University Center for Infection & Immunity



VIRAL FINDINGS

P2

Zaire ebolavirus

*As part of the Ebola Host Project, samples are being tested at Columbia University to accelerate release of viral findings for use for decision-making and risk-mitigation efforts.

LIBERIA

Global Health Security Agenda

JACKSON PULTOLNOR

PREDICT/Liberia, Team Lead

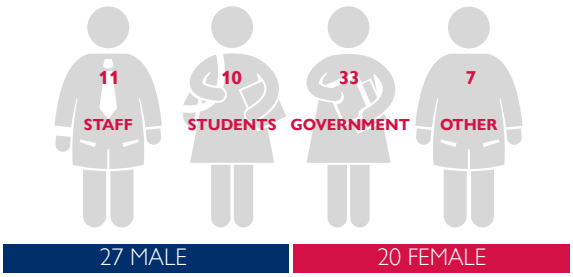
Society for the Conservation of Nature, Liberia

PARTNERS

- EcoHealth Alliance
- National Public Health Institute of Liberia
- Columbia University Center for Infection & Immunity

With Jackson's experience on the PREDICT project, he hopes to continue working in the conservation and One Health fields and combine that with his previous interest in sustainable farming and forestry. Jackson is poised to become one of the future Liberian leaders in these fields.

WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE

IMPACT

47 trained in One Health skills

346 individuals sampled (animals & humans)

131 individuals interviewed

2 unique viruses detected

VIRAL FINDINGS

P1	P2
55 new viruses	**1** PREDICT-1 viruses
13 known viruses	**1** known viruses

REPUBLIC OF CONGO

CYNTHIA GOMA-NKOUA

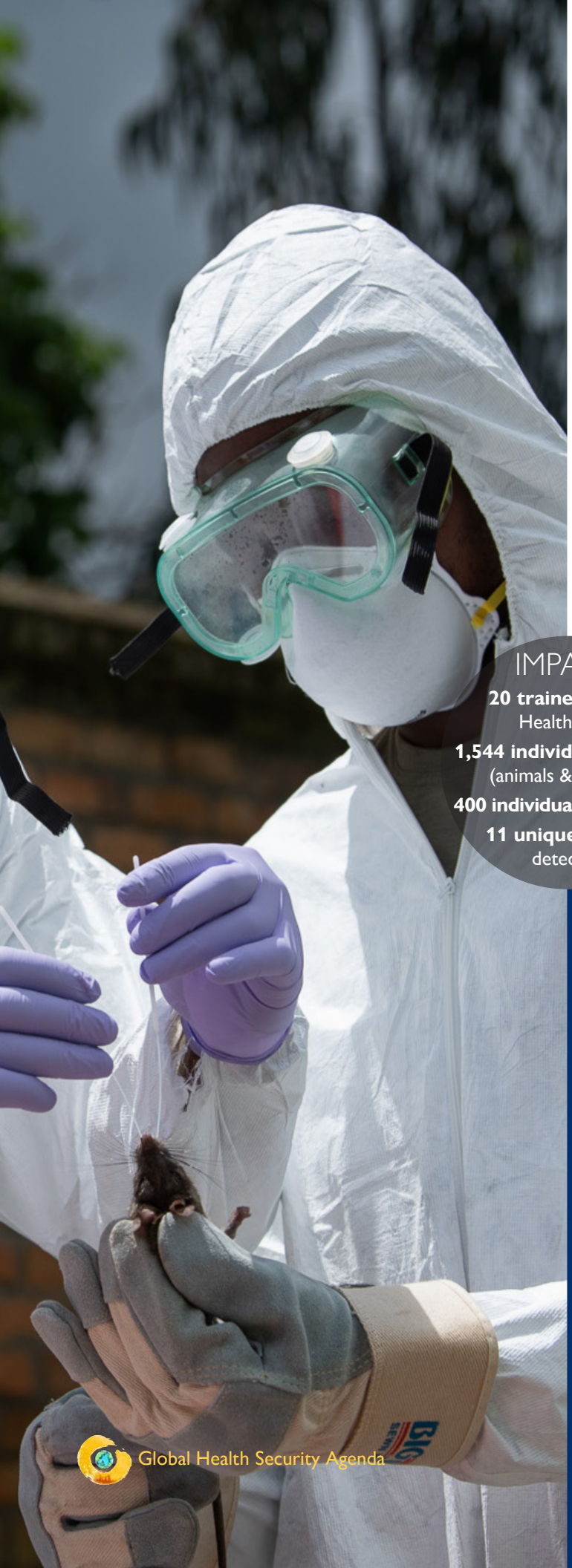
PREDICT/RoC, Country Coordinator

National Public Health Laboratory

PARTNERS

- EcoHealth Alliance
- Laboratoire National de Sante Publique (LNSP)

"I am currently the head of the Molecular Epidemiology Service laboratory of the National Public Health Laboratory (LNSP) in Brazzaville. My passion for infectious diseases began in 1995 when I saw the movie "Outbreak" about the spread of Ebola."



Global Health Security Agenda

IMPACT

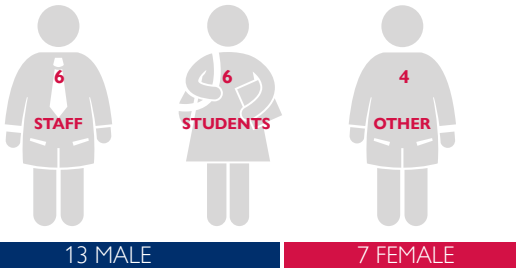
20 trained in One Health skills

1,544 individuals sampled (animals & humans)

400 individuals interviewed

11 unique viruses detected

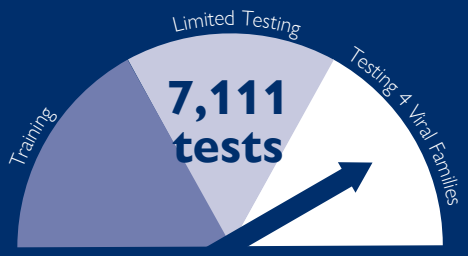
WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE

LAB STRENGTHENING

- Rwanda Agricultural Board Wildlife Virology Laboratory
- National Reference Lab/Rwanda Biomedical Center



VIRAL FINDINGS

P1	P2
16 new viruses	**2** new viruses
11 known viruses	**2** PREDICT-1 viruses
	7 known viruses

RWANDA

ADRIEN EMILE NTWALI

PREDICT/Rwanda, Field Veterinarian

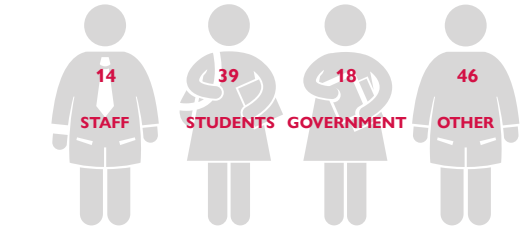
Gorilla Doctors

PARTNERS

- Mountain Gorilla Veterinary Project/Gorilla Doctors
- University of California, Davis
- Rwanda Agriculture Board
- National Reference Laboratory/ Rwanda Biomedical Center

"Gorilla Doctors (PREDICT implementing partner) are always ready to save the lives of gorillas anytime, no matter how the weather is looking, no matter what time of the day or week, no matter how far the gorillas are in the forest, no matter what circumstances."

WORKFORCE DEVELOPMENT



54 MALE | 25 FEMALE

ONE HEALTH SURVEILLANCE

IMPACT

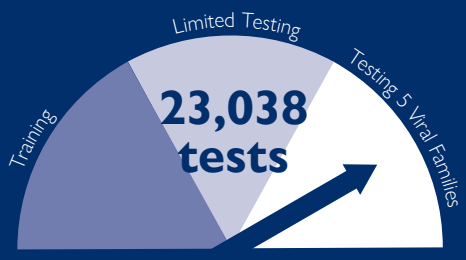
79 trained in One Health skills

1,671 individuals sampled (animals & humans)

795 individuals interviewed

LAB STRENGTHENING

- L'Institut Senegalais de Recherches Agricoles
- Cheikh Anta Diop University



Global Health Security Agenda

SENEGAL

AMINATA BA

PREDICT/Senegal, Laboratory Technician

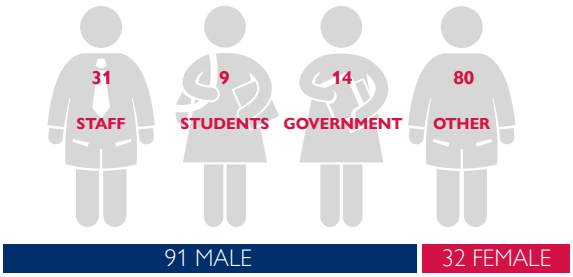
National Veterinary Laboratory

PARTNERS

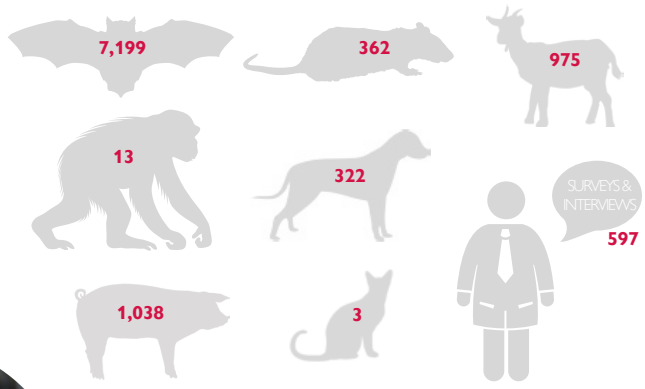
- University of California, Davis
- Inter State School of Veterinary Science & Medicine of Dakar
- Cheikh Anta Diop University/ Dantec University Hospital
- L'Institut Senegalais de Recherches Agricoles

"For me, the USAID/PREDICT project is a great experience, fitting perfectly into the One Health concept. This project has allowed me to broaden my skills in molecular diagnostics of highly pathogenic and critically important viral families."

WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE



IMPACT

123 trained in One Health skills

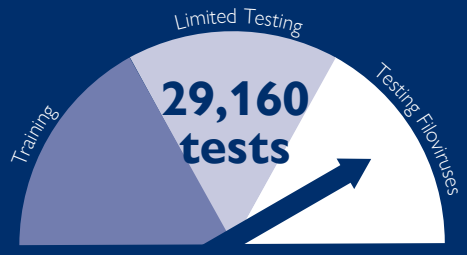
9,912 individuals sampled

597 individuals interviewed

2 unique viruses detected

LAB STRENGTHENING

- University of Makeni
- UC Davis One Health Institute



VIRAL FINDINGS

P2

1 new virus (*Bombali ebolavirus*)

1 known virus (Marburg virus)

*As part of the Ebola Host Project, samples are being tested at UC Davis to accelerate release of viral findings for use for decision-making and risk-mitigation efforts.

Global Health Security Agenda

SIERRA LEONE

EDWIN LAVALIE

PREDICT/Sierra Leone, Field Ecologist

University of Makeni

ABDULAI BANGURA

PREDICT/Sierra Leone, Field Ecologist

University of Makeni

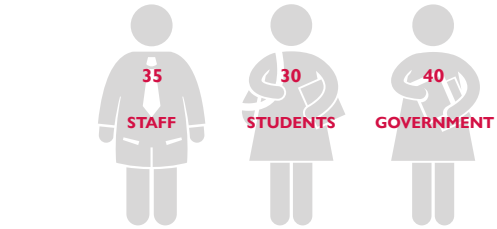
PARTNERS

- University of California, Davis
- University of Makeni

"I am most proud of being able work in a community that do not have knowledge of my job, using my skills for community to trust our ideas and allow us to capture animals, safely process them. Most importantly, I am most proud of working as a Sierra Leonean scientist that discovered the BOMBALI Ebola virus and the Marburg virus."

"I personally enjoy making trips to remote villages, forests and caves to trap and sample animals. It gives me the opportunity to interact with nature and see the rich biodiversity of our land, which is always hard to resist even when taken into consideration how risky our work is. It gives that pride, confidence and respect about the work we do for each sampling trip as a team. In addition, I am really proud of the work we do sensitizing people on how to safely live with animals, stimulating huge behavioral change in the lives of locals."

WORKFORCE DEVELOPMENT



52 MALE | 71 FEMALE

*One individual gender unknown

ONE HEALTH SURVEILLANCE

IMPACT

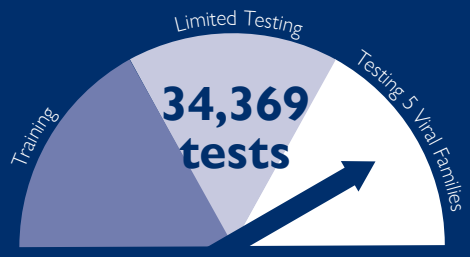
124 trained in One Health skills*

4,039 individuals sampled (animals & humans)

1,574 individuals interviewed

LAB STRENGTHENING

- Ifakara Health Institute
- Sokoine University of Agriculture



VIRAL FINDINGS

P1	P2
15 new viruses	**6** new viruses
12 known viruses	**4** known viruses

Global Health Security Agenda

TANZANIA

HAPPY RAPHAEL MKALI

PREDICT/Tanzania, Laboratory Lead

Ifakara Health Institute

WALTER SIMON MAGESA

PREDICT/Tanzania, Laboratory Scientist

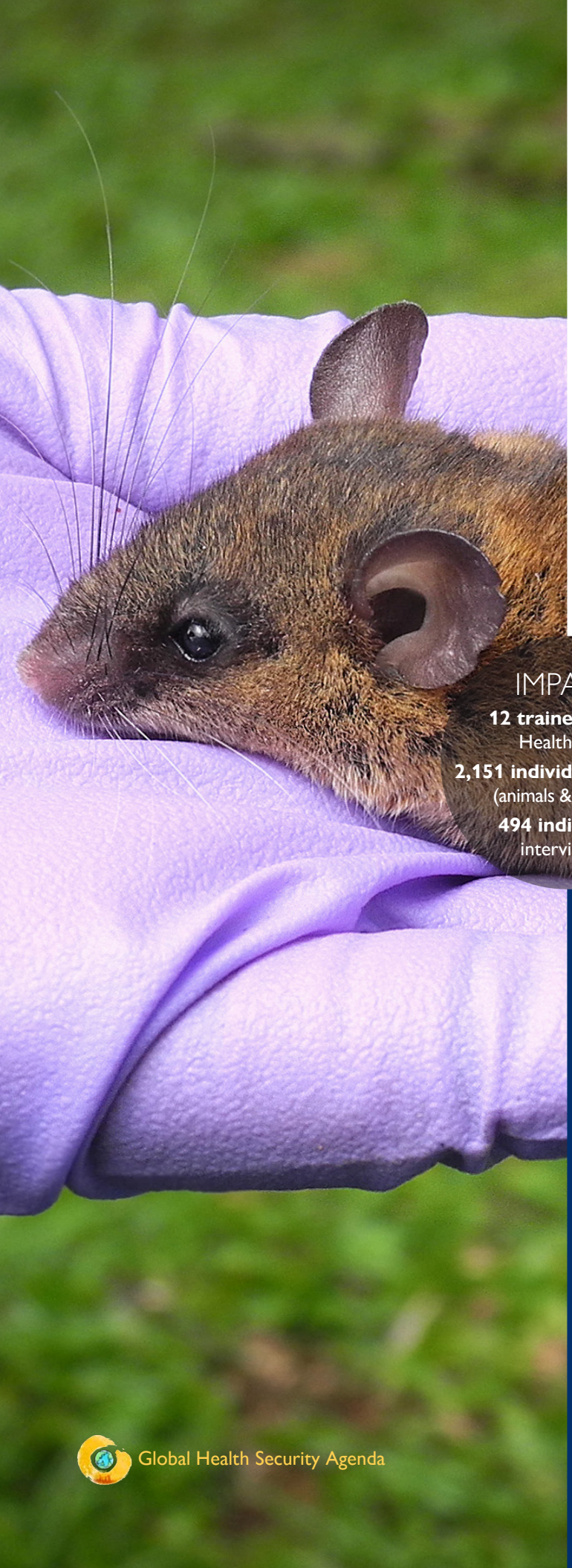
Sokoine University of Agriculture

PARTNERS

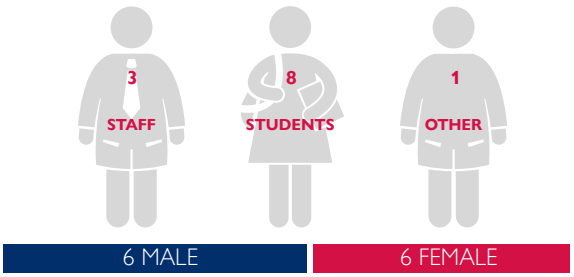
- University of California, Davis
- Sokoine University of Agriculture
- Ifakara Health Institute

"The capacity building of local experts on surveillance and detection of known and unknown pathogens of pandemic potential and the One Heath approach makes me really enjoy working with PREDICT, interacting with people from different disciplines (including veterinary, public health and social science professionals), who all work together and share experiences on solving community health issues."

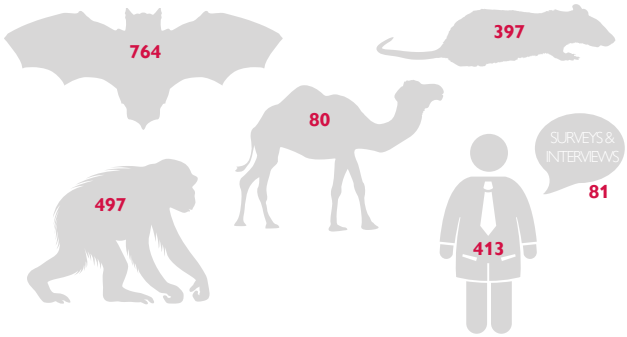
"What I really enjoy about working with PREDICT is the beauty of interacting with teams of different disciplines—from veterinarians to social scientists to the public health professionals, who all together have brought different experiences on how to approach zoonoses and other One Health issues around our communities."



WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE



IMPACT

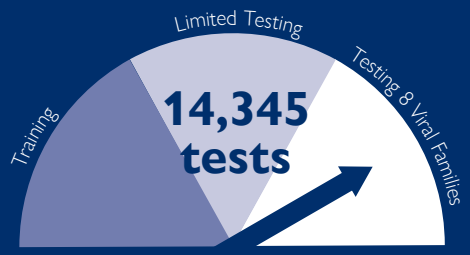
12 trained in One Health skills

2,151 individuals sampled (animals & humans)

494 individuals interviewed

LAB STRENGTHENING

- Uganda Viral Research Institute
- Makerere University Walter Reed Project



VIRAL FINDINGS

P1	P2
39 new viruses	
17 known viruses	

Global Health Security Agenda

UGANDA

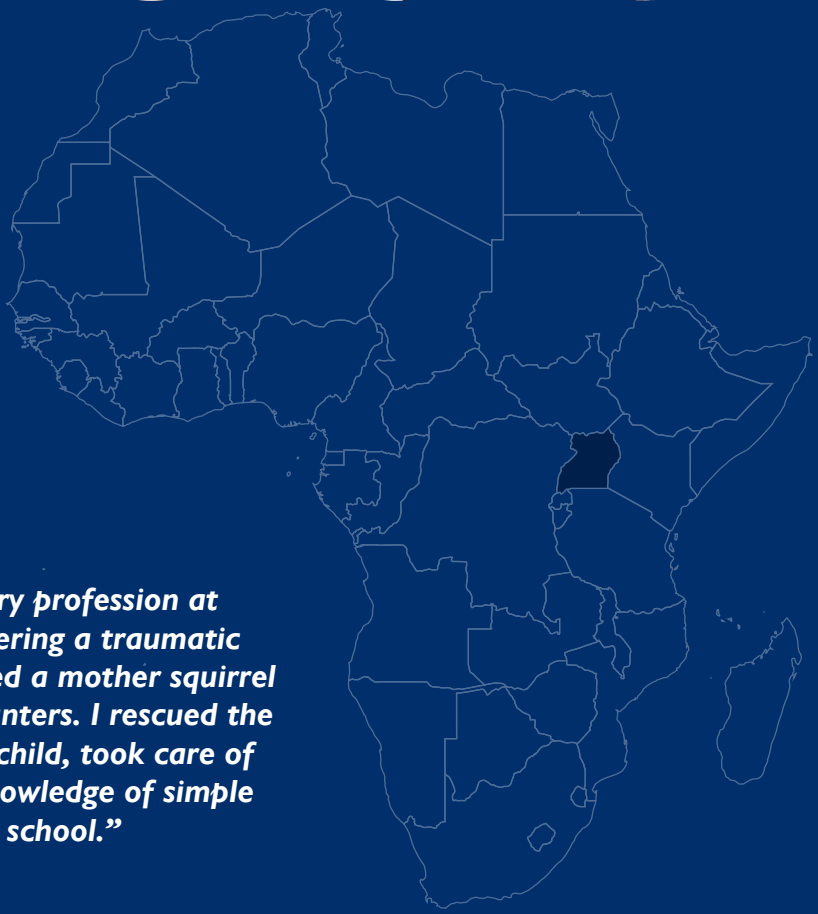
RICKY OKELLO OKWIR

PREDICT/Uganda, Field Veterinarian

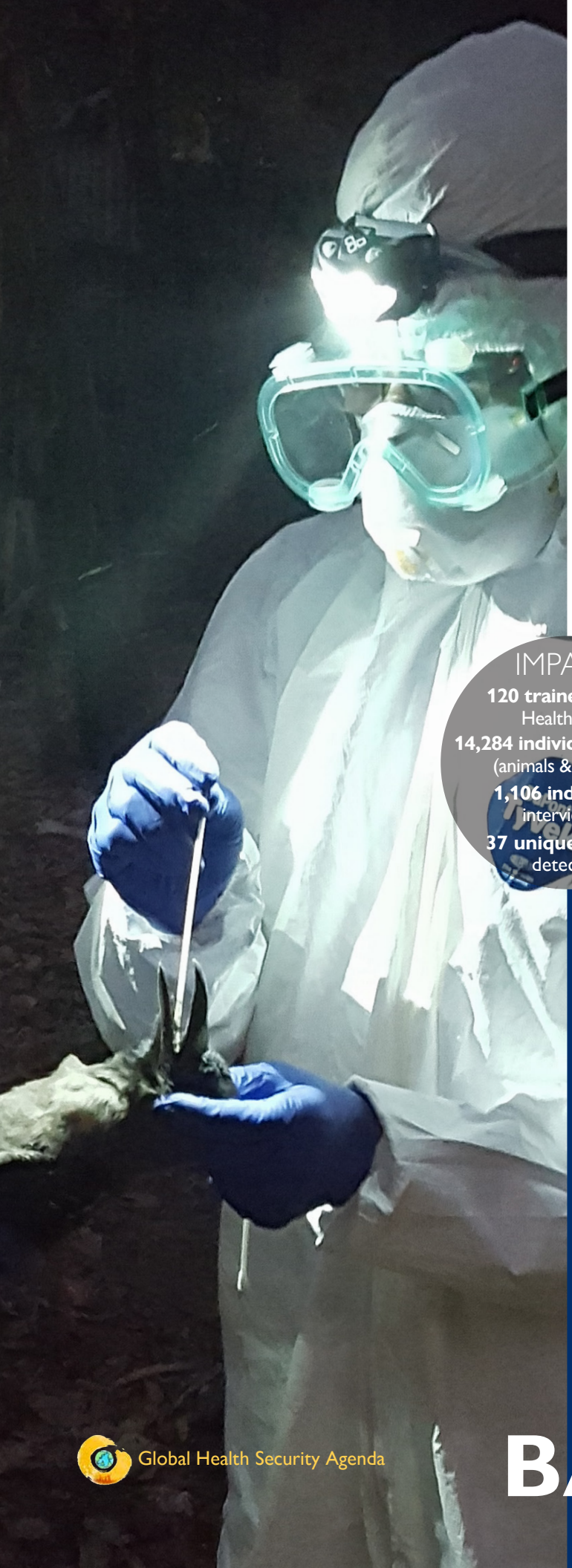
Gorilla Doctors

PARTNERS

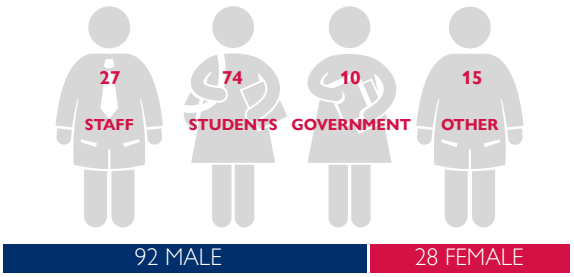
- Mountain Gorilla Veterinary Project/Gorilla Doctors
- University of California, Davis
- Uganda Viral Research Institute
- Makerere University Walter Reed Project



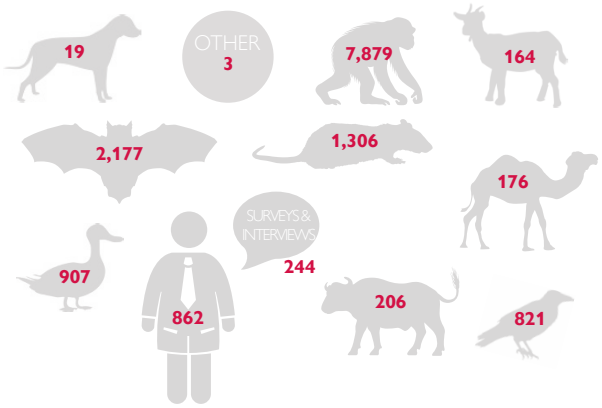
"I was compelled to enter the veterinary profession at an early age of just 10 years after suffering a traumatic incident in our remote village. I watched a mother squirrel and her baby speared by a group of hunters. I rescued the squirrels, and as a young school-going child, took care of the two squirrels from just my basic knowledge of simple wound treatment that I had learned in school."



WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE



IMPACT

120 trained in One Health skills

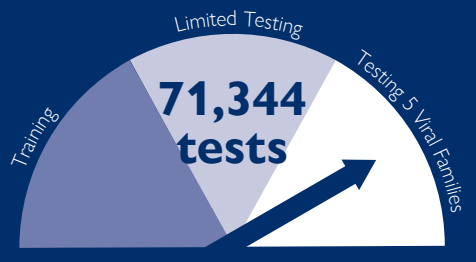
14,284 individuals sampled (animals & humans)

1,106 individuals interviewed

37 unique viruses detected

LAB STRENGTHENING

- Institute of Epidemiology, Disease Control & Research
- icddr,b



VIRAL FINDINGS

P1	P2
217 new viruses	**11** new viruses
20 known viruses	**8** PREDICT-1 viruses
	18 known viruses

Global Health Security Agenda

BANGLADESH

SHARIFUL ISLAM

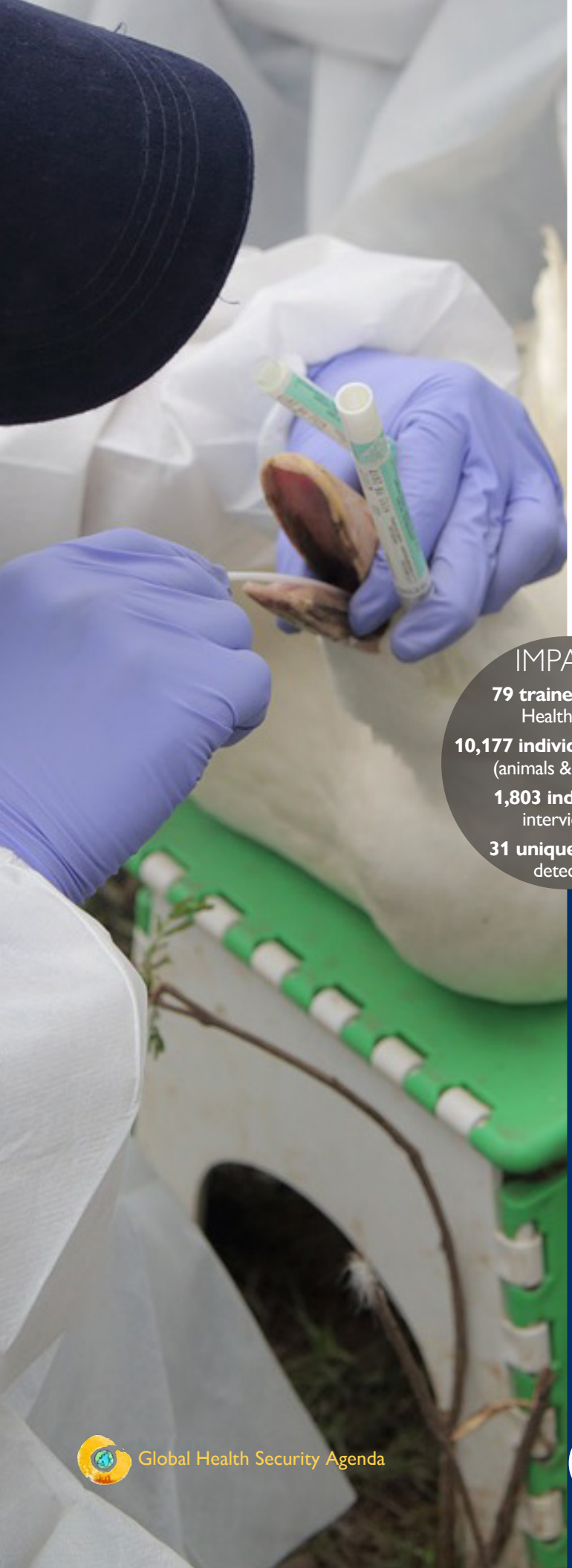
PREDICT/Bangladesh, Field Coordinator-Epidemiology

Institute of Epidemiology Disease Control & Research

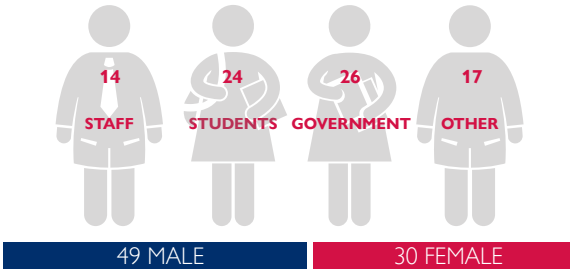
PARTNERS

- EcoHealth Alliance
- icddr,b
- Institute of Epidemiology, Disease Control & Research
- Bangladesh Forest Department

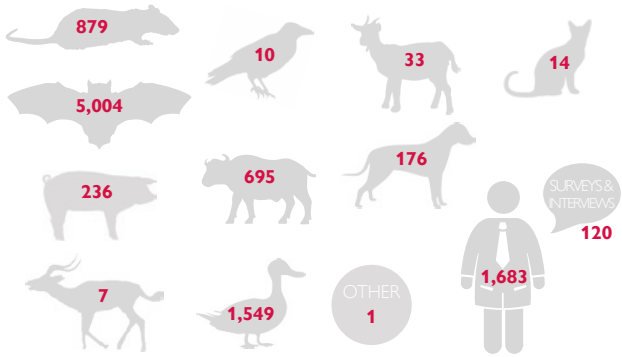
Dr. Islam has been leading field teams with multisectoral representation to conduct ecological and epidemiological studies of zoonotic viruses in wildlife. While in the field, Dr. Islam collects biological samples from various wildlife species, including bats, macaques, rodents, shrews and wild birds.



WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE



IMPACT

79 trained in One Health skills

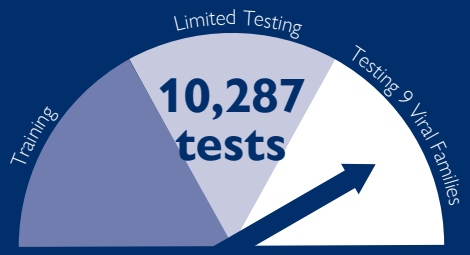
10,177 individuals sampled (animals & humans)

1,803 individuals interviewed

31 unique viruses detected

LAB STRENGTHENING

· Institut Pasteur du Cambodge



VIRAL FINDINGS

P1	P2
29 new viruses	**7** new viruses
18 known viruses	**11** PREDICT-1 viruses
	13 known viruses

Global Health Security Agenda

CAMBODIA

VEASNA DUONG

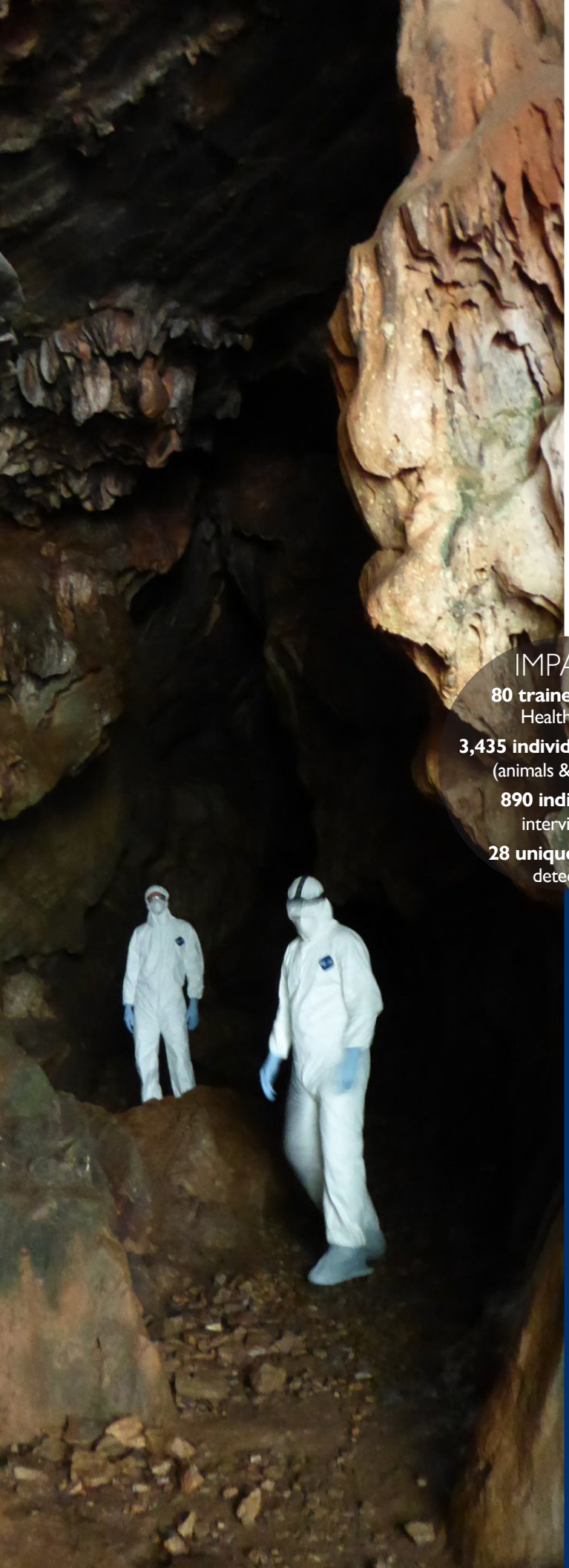
PREDICT/Cambodia, Country Coordinator

Institut Pasteur du Cambodge

PARTNERS

- University of California, Davis
- Institut Pasteur du Cambodge

"PREDICT has introduced and built capacity here for effective One Health approach to tackle emerging zoonotic viruses with potential threat to Cambodia and the world."



IMPACT

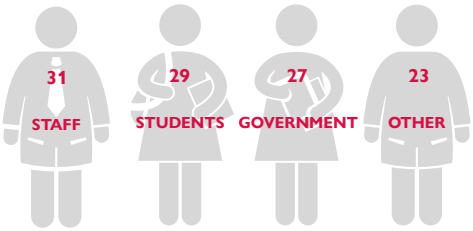
80 trained in One Health skills

3,435 individuals sampled (animals & humans)

890 individuals interviewed

28 unique viruses detected

WORKFORCE DEVELOPMENT

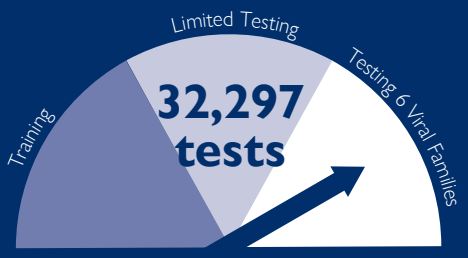


40 MALE | 40 FEMALE

ONE HEALTH SURVEILLANCE

LAB STRENGTHENING

- Wuhan Institute of Virology of Chinese Academy of Sciences
- Institute of Microbiology of Chinese Academy of Sciences



VIRAL FINDINGS

P1	P2
46 new viruses	**11** new viruses
22 known viruses	**5** PREDICT-1 viruses
	12 known viruses

CHINA

GUANGJIAN ZHU, PhD

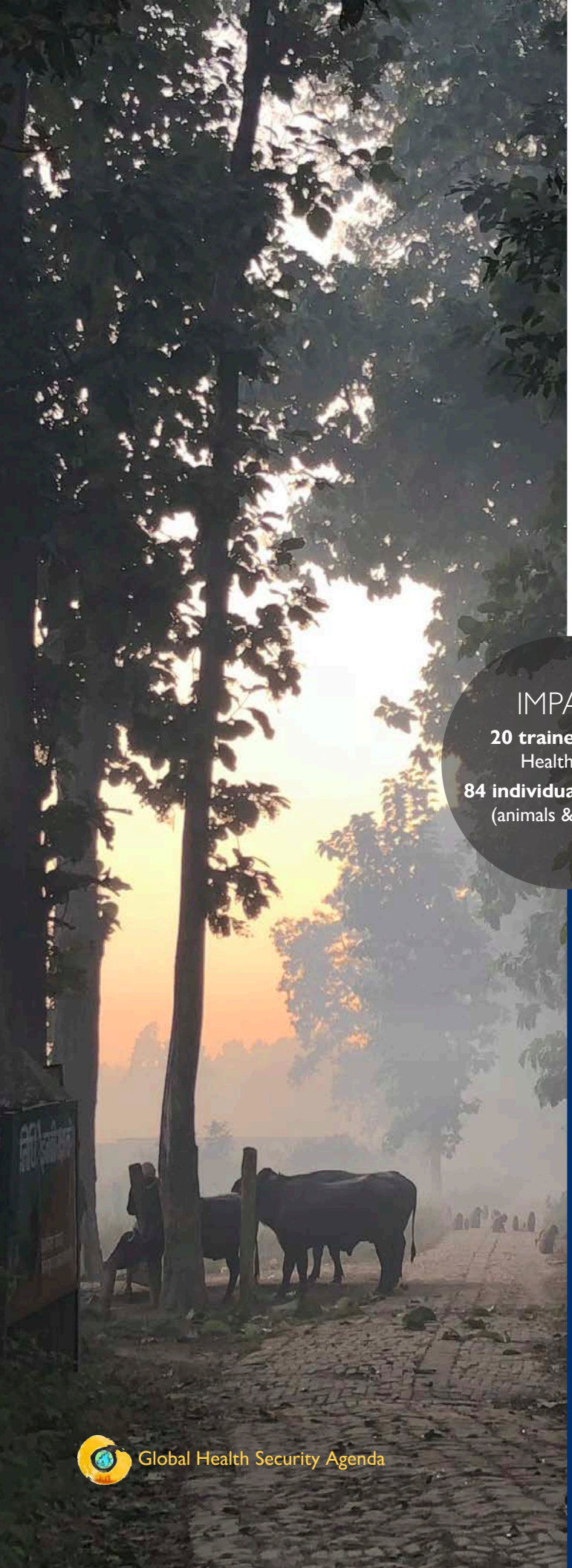
PREDICT/China, Field Coordinator

EcoHealth Alliance

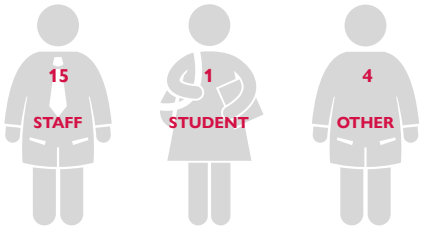
PARTNERS

- EcoHealth Alliance
- Wuhan Institute of Virology of Chinese Academy of Sciences
- Institute of Microbiology of Chinese Academy of Sciences
- Chinese Center for Disease Control & Prevention

"I believe every individual who works with PREDICT is the key of its success. The greater success of PREDICT in China lies in the sharing and collaborating with the world."

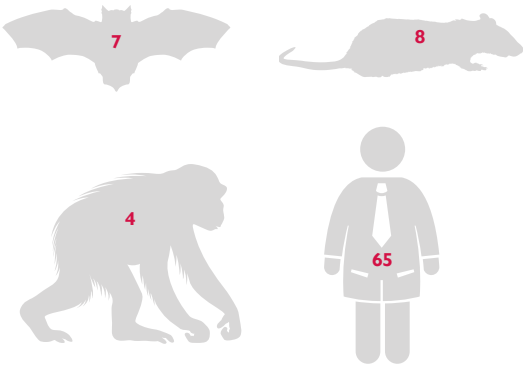


WORKFORCE DEVELOPMENT



15 MALE | 5 FEMALE

ONE HEALTH SURVEILLANCE



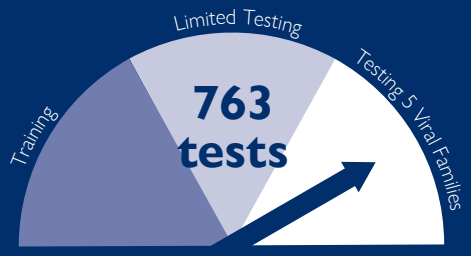
IMPACT

20 trained in One Health skills

84 individuals sampled (animals & humans)

LAB STRENGTHENING

- Sanjay Ghandi Postgraduate Institute of Medical Sciences



Global Health Security Agenda

INDIA

HARJEET SINGH MAAN

PREDICT/India, Laboratory Lead

Sanjay Gandhi Postgraduate Institute of Medical Sciences

PARTNERS

- EcoHealth Alliance
- Sanjay Gandhi Postgraduate Institute of Medical Sciences

"I have since taken my expertise in microbiology to work as a Senior Scientist at the State Virology laboratory, at Gandhi Medical College in Bhopal Madhya Pradesh, India, where I am now in charge of a virology lab."

IMPACT

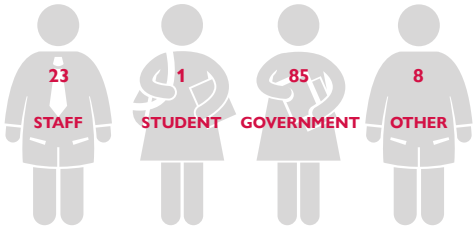
117 trained in One Health skills

3,218 individuals sampled (animals & humans)

988 individuals interviewed

27 unique viruses detected

WORKFORCE DEVELOPMENT

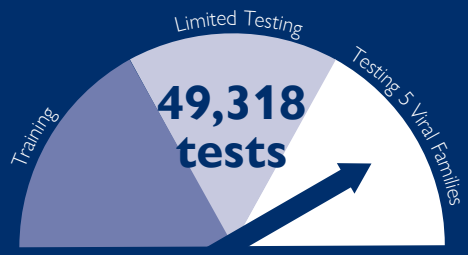


45 MALE | 72 FEMALE

ONE HEALTH SURVEILLANCE

LAB STRENGTHENING

- Eijkman Institute for Molecular Biology (EIMB)
- Primate Research Center of the Institut Pertanian Bogor (Bogor Agricultural University)



VIRAL FINDINGS

P1	P2
14 new viruses	**14** new viruses
6 known viruses	**5** PREDICT-1 viruses
	8 known viruses

Global Health Security Agenda

INDONESIA

UUS SAEPULOH, SSi, M.Biomed

PREDICT/Indonesia, Laboratory Technologist

Primate Research Center IPB University

TINA KUSUMANINGRUM, MSc

PREDICT/Indonesia, Field Coordinator

PARTNERS

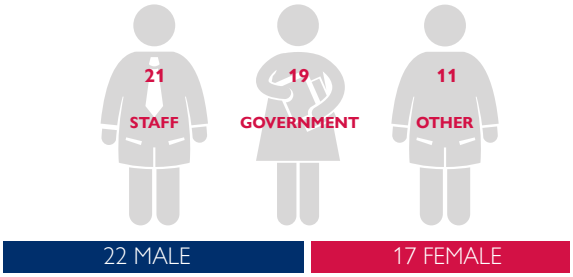
- EcoHealth Alliance
- Primate Research Center of the Institut Pertanian Bogor (Bogor Agricultural University)
- Eijkman Institute for Molecular Biology

"PREDICT has given me an opportunity to be a part of global research communities in fighting zoonotic diseases through multisectoral collaboration."

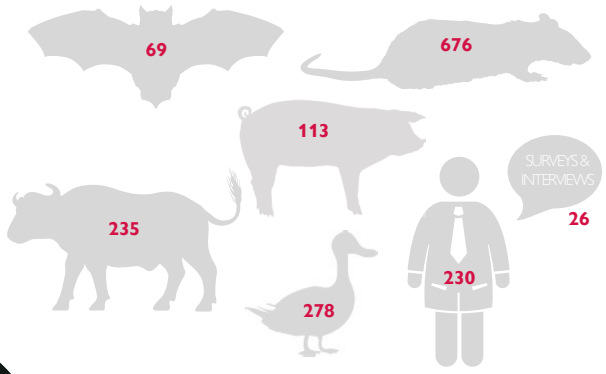
"Since I joined PREDICT/Indonesia, I've had many opportunities to improve my knowledge and skills in molecular biology and virology, especially in best practices for viral detection, surveillance, and biosecurity. I hope this knowledge and my ability to share it will increase and strengthen the capacity of laboratory technologies in our institution and across Indonesia for detecting wildlife zoonotic agents."

Global Health Security Agenda

WORKFORCE DEVELOPMENT



ONE HEALTH SURVEILLANCE



IMPACT

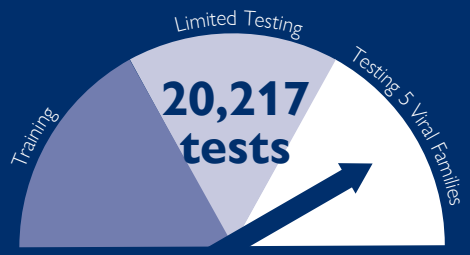
39 trained in One Health skills

1,601 individuals sampled (animals & humans)

256 individuals interviewed

LAB STRENGTHENING

- National Center for Laboratory & Epidemiology
- National Animal Health Laboratory



VIRAL FINDINGS

P1	P2
16 new viruses	**5** known viruses
5 known viruses	**2** new viruses

LAO PDR

SINAKHONE XAYADETH

PREDICT/Lao PDR, Laboratory Technician

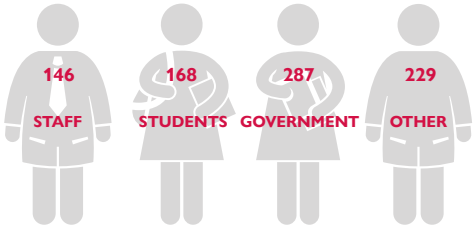
National Center for Laboratory & Epidemiology

PARTNERS

- Metabiota, Inc.
- National Animal Health Laboratory
- National Center for Laboratory & Epidemiology

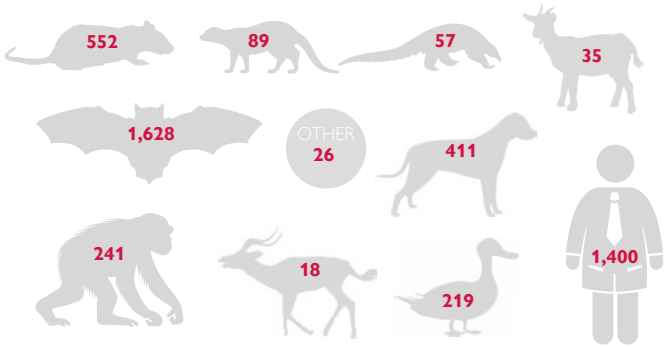
His experience working on the PREDICT project has motivated Sinakhone to further improve the laboratory capacity of his country, with his sights set on continuing his education in advanced molecular laboratory techniques. While the benefits of equipment and supplies, shared protocols, and in-service trainings provided to an organization are clear, the transfer of knowledge, mentorship, and inspiration ignited through involvement in a global project like PREDICT are also of great value and can have long-lasting and far-reaching effects.

WORKFORCE DEVELOPMENT



343 MALE | 280 FEMALE

ONE HEALTH SURVEILLANCE



IMPACT

597 trained in One Health skills

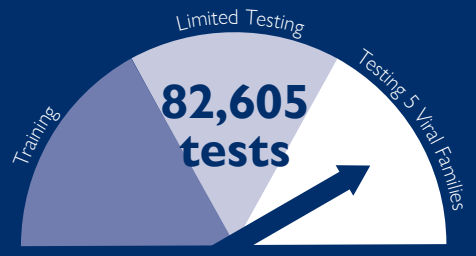
4,676 individuals sampled (animals & humans)

1,400 individuals interviewed

28 unique viruses detected

LAB STRENGTHENING

- Wildlife Health, Genetic & Forensic Laboratory, Sabah Wildlife Department
- Virology Lab, Faculty of Veterinary Medicine, University Putra, Malaysia
- PERHILITAN National Wildlife Forensic Laboratory
- National Public Health Laboratory Peninsular Malaysia
- Kota Kinablu Public Health Laboratory



VIRAL FINDINGS

P1

57 new viruses
19 known viruses

P2

17 new viruses
3 PREDICT-1 viruses
8 known viruses

MALAYSIA

ZAHIDAH IZZATI ZEID

PREDICT/Malaysia Veterinarian

EcoHealth Alliance

PARTNERS

- EcoHealth Alliance
- Conservation Medicine, Ltd.
- PERHILITAN & National Wildlife Forensic Laboratory
- Sabah Wildlife Department, Wildlife Health, Genetic & Forensic Laboratory
- Danau Girang Field Centre
- University Malaysia Sabah
- Sabah State Health Department
- Queen Elizabeth Hospital

Dr. Zahidah has quickly become an important member of the PREDICT team in Malaysia working closely with government partners to build capacity to reduce the likelihood of spillover events.

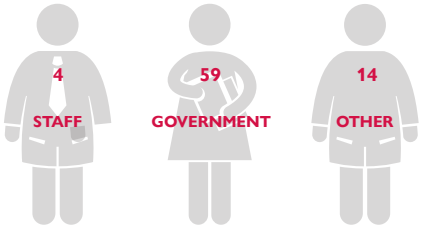
IMPACT

76 trained in One Health skills

3,243 animals sampled

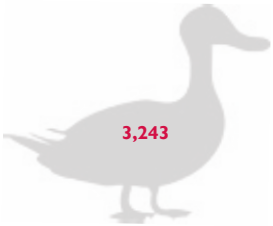
1 unique virus detected

WORKFORCE DEVELOPMENT



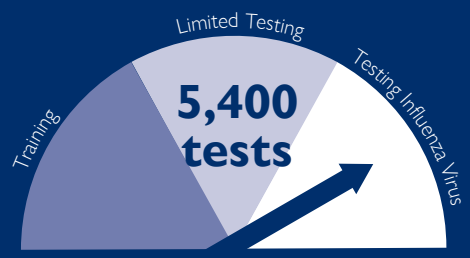
51 MALE | 25 FEMALE

ONE HEALTH SURVEILLANCE



LAB STRENGTHENING

- State Central Veterinary Laboratory



VIRAL FINDINGS

P2

Influenza virus

MONGOLIA

ULAANKHUU ANKHANBAATAR

PREDICT/Mongolia, Virologist

State Central Veterinary Laboratory

PARTNERS

- Wildlife Conservation Society
- State Central Veterinary Laboratory

ARIUNBAATAR BARKHASBAATAR

PREDICT/Mongolia, Avian Specialist

Wildlife Conservation Society

"I am really interested in wildlife disease in the future."

"Working with the international project team has been a great opportunity for my further research. Also my bird identification has improved."

IMPACT

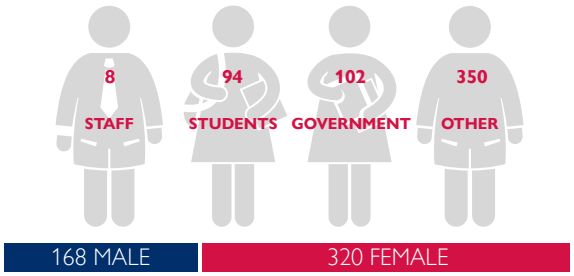
488 trained in One Health skills

3,611 individuals sampled (animals & humans)

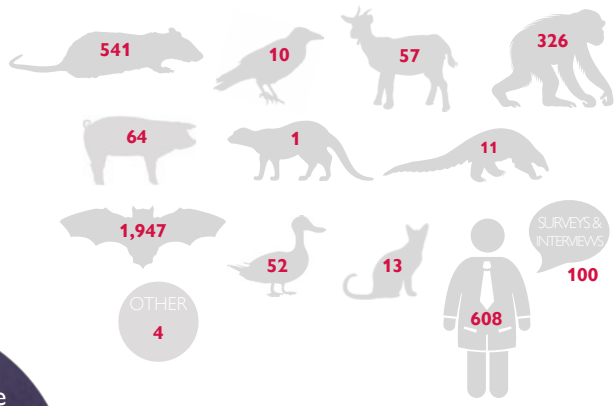
708 individuals interviewed

9 unique viruses detected

WORKFORCE DEVELOPMENT

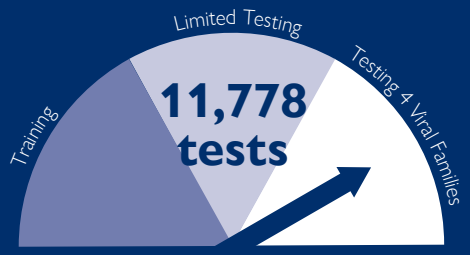


ONE HEALTH SURVEILLANCE



LAB STRENGTHENING

- Livestock Breeding & Veterinary Department
- Department of Medical Research



VIRAL FINDINGS

P2

6 new viruses

3 PREDICT-1 viruses

MYANMAR

OHNMAR AUNG, MD

PREDICT/Myanmar, Country Coordinator

Smithsonian Institution

PARTNERS

- Smithsonian Institution
- Department of Medical Research of the Ministry of Health & Sports
- Livestock Breeding & Veterinary Department
- Laboratory of the Ministry of Livestock, Agriculture & Irrigation
- Ministry of Natural Resources & Environmental Conservation

Dr. Ohnmar Aung is a medical doctor and social scientist. As the country coordinator for PREDICT in Myanmar, she is responsible for guiding and coordinating the project within the country, alongside Myanmar's three ministry partners. Dr. Aung has been a practicing physician for more than 15 years and has extensive experience bringing health infrastructure to communities throughout the country.

IMPACT

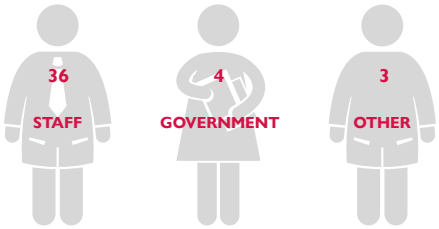
43 trained in One Health skills

4,452 individuals sampled (animals & humans)

2,143 individuals interviewed

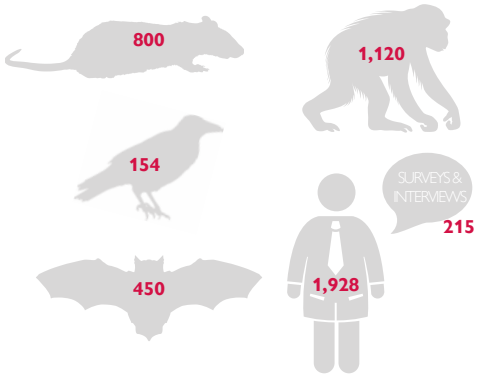
8 unique viruses detected

WORKFORCE DEVELOPMENT



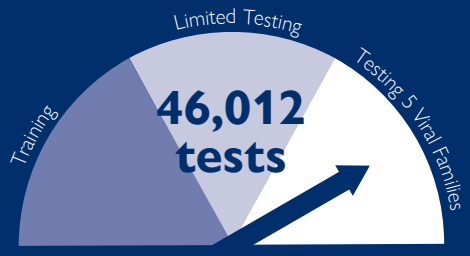
28 MALE | 15 FEMALE

ONE HEALTH SURVEILLANCE



LAB STRENGTHENING

· Center for Molecular Dynamics Nepal/ Intrepid Nepal



VIRAL FINDINGS

P1	P2
6 new viruses	**1** new viruses
5 known viruses	**7** known viruses

NEPAL

DIBESH KARMACHARYA, PhD

PREDICT/Nepal, Country Coordinator

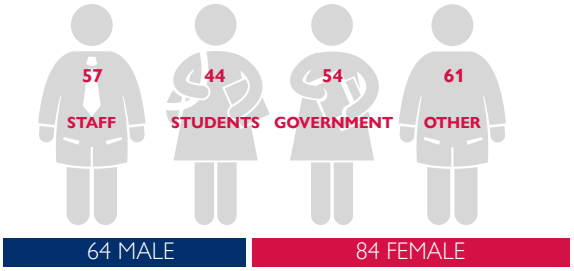
Center for Molecular Dynamics Nepal

PARTNERS

- University of California, Davis
- Center for Molecular Dynamics Nepal/Intrepid Nepal

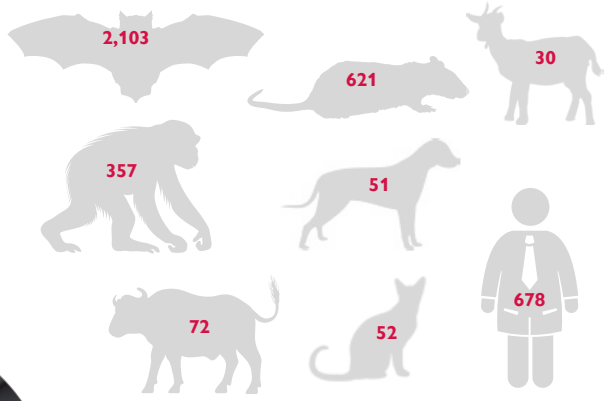
"PREDICT has helped in building capacity for emerging disease detection and characterization in Nepal, greatly enhancing country's surveillance capabilities."

WORKFORCE DEVELOPMENT



64 MALE | 84 FEMALE

ONE HEALTH SURVEILLANCE



IMPACT

148 trained in One Health skills

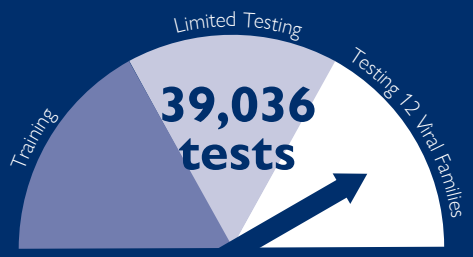
3,964 individuals sampled (animals & humans)

678 individuals interviewed

34 unique viruses detected

LAB STRENGTHENING

- WHO-CC Viral Zoonoses Chulalongkorn University



VIRAL FINDINGS

P1	P2
83 new viruses	**6** new viruses
34 known viruses	**14** known viruses
	14 PREDICT-1

Global Health Security Agenda

THAILAND

PRATEEP DUENGKAE, PhD

PREDICT/Thailand, Co-Country Coordinator

Faculty of Forestry at Kasetsart University

AINGORN CHAIYES

PREDICT/Thailand, Modeling & Analytics Fellow

PARTNERS

- EcoHealth Alliance
- Chulalongkorn University Hospital
- Kasetsart University
- Department of National Parks, Wildlife & Plant Conservation
- Department of Livestock & Development
- Ministry of Public Health

"I was awarded a PREDICT Modeling & Analytics Fellowship to work with the team at EcoHealth Alliance in New York City. The fellowship helped me to expand my work to evaluate habitat suitability and Nipah Virus Risk of Lyle's Flying Fox in Thailand. The methods and techniques I learned as part of PREDICT will help me promote the conservation and management of wildlife and wildlife diseases in Thailand and transfer this knowledge to others."

"I spent my whole career studying the wildlife and natural ecosystems of Thailand. Joining the PREDICT project opened up a whole new area of research for me, and has allowed me to link my knowledge of ecology and animal biology with infectious disease research. It's been exciting to see how PREDICT has helped to shape the national agenda for One Health in Thailand".

IMPACT

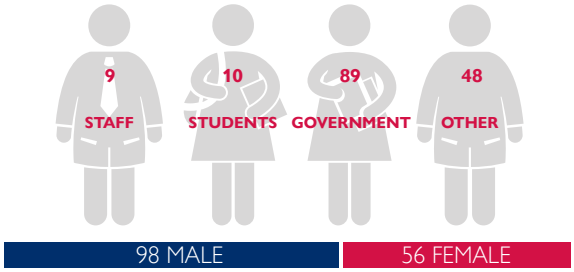
154 trained in One Health skills

4,712 individuals sampled (animals & humans)

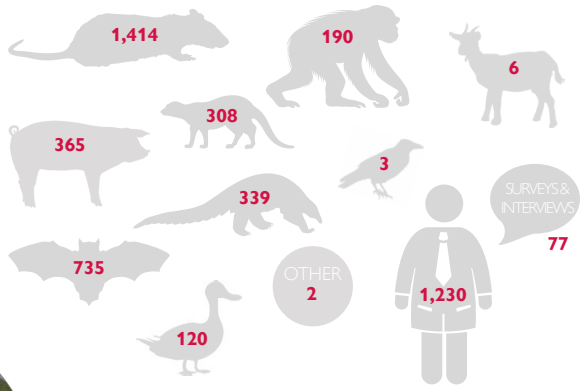
1,307 individuals interviewed

9 unique viruses detected

WORKFORCE DEVELOPMENT

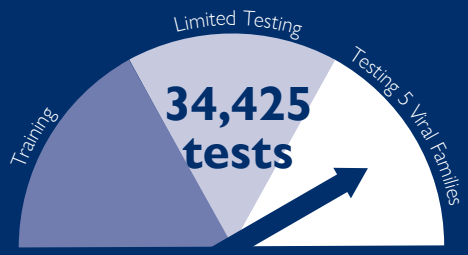


ONE HEALTH SURVEILLANCE



LAB STRENGTHENING

- Viet Nam National University of Agriculture
- Regional Animal Health Office No. 6
- National Institute of Hygiene & Epidemiology



VIRAL FINDINGS

P1	P2
23 new viruses	**2** new viruses
7 known viruses	**1** PREDICT-1 virus
	6 known viruses

VIET NAM

Global Health Security Agenda

NGUYEN THI THANH NGA

PREDICT/Viet Nam, Country Coordinator

Wildlife Conservation Society

NGUYEN DUC THINH

PREDICT/Viet Nam, Laboratory Technician

Viet Nam National University of Agriculture

PARTNERS

- Wildlife Conservation Society
- Viet Nam National University of Agriculture
- Regional Animal Health Office Laboratories (RAHO6 & RAHO7), Department of Animal Health
- National Institute of Hygiene & Epidemiology

"PREDICT is so meaningful not only to me but also globally because of its One Health approach. This is also my first time to work together with wildlife and animal health staffs and I feel very happy to be able to be a part of it."

"I started my career as a member of the PREDICT project program. Being a part of the team has helped me to deepen my expertise, improved my skills, and has given me a golden chance to explore the areas that I'm interested in, that is wildlife, wildlife health and zoonotic diseases. I believe and hope that PREDICT project will not only help me to enhance my personal veterinary skills but its findings will also bring value to animal and human health, and especially the wildlife health in Viet Nam."

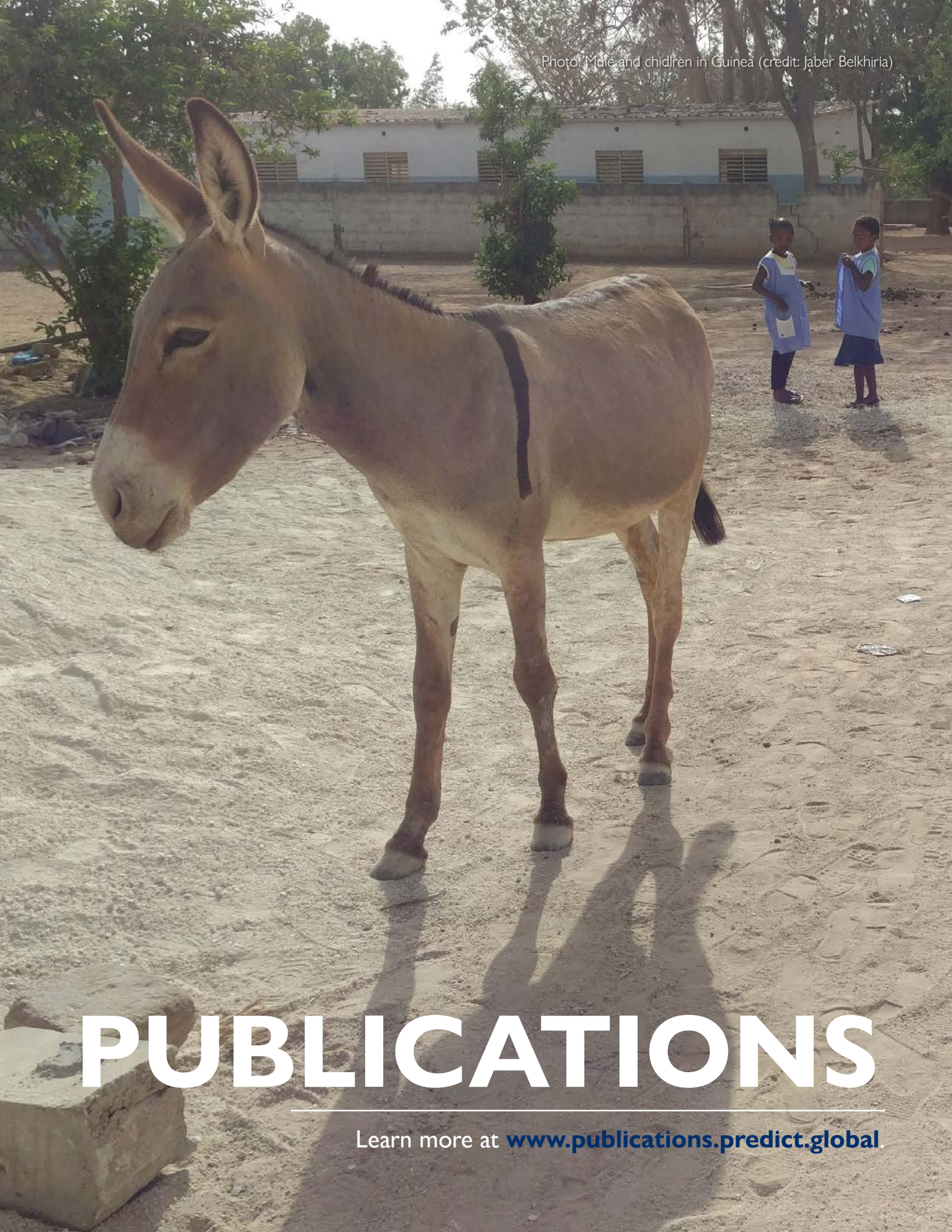


Photo: Mule and chidlren in Guinea (credit: Jaber Belkhiria)

PUBLICATIONS

Learn more at **www.publications.predict.global**.

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